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Concrete For Track Elevation Bridges

A FEW years ago when extensive track elevation projects first began to be mapped out, the structures to carry tracks over streets where the headroom was restricted were almost universally built of steel. It is true that concrete was used in the substructures, but so little development had taken place in the design of concrete superstructures that it was deemed advisable by all engineers to use structural steel for all the main members and sometimes for the entire bridge superstructure.

It was soon found that concrete floors were excellent for track elevation bridges, eliminating some of the noise, the dripping of water and dirt upon the street below and making a better riding and more easily maintained track, which was of course ballasted. Various types of concrete floors such as jack arch construction and reinforced slabs on steel floor beams or stringers were evolved, the general tendency being toward the lengthening of the span of the floor slab.

After the first steel track elevation bridges were erected and their characteristic unsightliness impressed upon the public, more pleasing looking bridges were demanded in many places and structures of steel were therefore encased in concrete, molded in various lines so as to more nearly harmonize with the surroundings, especially in residence districts. This type of construction is of necessity expensive and not economical, since the concrete only adds dead weight to the structure without aiding in carrying the loads; it, of course, does protect the steel from corrosion.

In the meantime the use of reinforced concrete had developed very rapidly and bridge engineers naturally looked to this material for a solution of the problem of obtaining economical bridges possessing beauty as well as strength. It is true that the first reinforced concrete track elevation bridges did not in all cases satisfy the criterion of beauty as well as utility, but this of necessity was to be expected, since the proper architectural treatment of concrete is so different from the then existing ideas of bridge architecture in stone and steel. The development of the architectural treatment and proper motif for concrete bridges of various types could only be a gradual one growing out of the continued association with the material.

The Chicago, Milwaukee & St. Paul Ry. is one of the pioneers in the use of reinforced concrete and was one of the first railroads to use reinforced concrete for track elevation structures. Some of the first structures were erected in 1908 in Evanston, Ill. These bridges were described on pages 37 and 38 of the January, 1913, issue of *Railway Engineering*, as were the later designs used in the Spokane track elevation work of this company involving the use of T-beam slabs for the first time in America. The main structural features having been worked out, more attention is now being given to architectural treatment, and some of the bridges on the Bloomingdale track elevation work now being carried out and described on another page evidence this fact. It is of special significance that reinforced concrete is being used in the construction of 32 of the 35 subways on this work; it proves more conclusively than ever that concrete is the best and most economical material for such work, besides allowing a wide scope of architectural treatment.

Structural steel subways are sometimes necessary for heavy skew crossings or where the underclearance is limited, but in general, concrete can be used for all but special structures, and in view of its economic features, involving better appearance and smaller maintenance cost as compared with steel bridges, it is difficult to see why some railways still cling to the use of structural steel for all track elevation work.

The Signal Engineer

SIGNAL ENGINEERING has reached the dignity of a specialized science, and will become more so as time goes on.

But the thorough signal engineer not only should know the intricate technical details of all types of signal appliances, but

should be an electro-civil engineer in addition. He should be familiar with all types of track and bridge work and intimately so with switch and frog construction and installation. He should understand thoroughly the application of all train rules and the details of train operation. And in these days of approaching automatic train control he must be an expert on airbrake appliances, construction and operation. In other words, the thorough signal engineer must now be a trained operating expert in all its branches.

Nearly all signal engineers of the railroads which have signal departments of several years' standing fulfill these requirements and have this knowledge. Yet very few signal engineers are given the opportunity of advancement into the operating and transportation departments that other members of the regular engineering force are offered. What is wrong, is it the individual or the organization? We are inclined to believe it is the organization, as the signal engineer has erected some splendid monuments of his capability and efficiency, both as an expert in his own specialty and as a broad operative official.

Is it not time for the managements to recognize more fully the splendid work that has been done by the signal engineer within the last twenty years? It does seem to be meet, at least, to now begin placing the signal department on its own footing and having the head of the department reporting to the executive operating head of the railroad company. Let us get away from that growing fallacy, "once a signal engineer always a signal engineer and nothing else."

Physical Valuation

IT HAS now been a year and five months since the bill calling for a physical valuation of the common carriers was enacted into a law. Since then there have been various contentions and discussions as to the eventual advisability and practicability of the work after it was completed. The bill was primarily advocated in order to give a basis for allowing rates to be made that would pay a "fair" interest on the actual property investment of the common carrier. It is extremely doubtful if this valuation can ever be "fairly" determined as applied to individual cases. When the law became effective the Government experts prophesied that it would take from five to seven years to complete the work. Although several of the railroads have long since established "physical valuation" forces to work in conjunction with the Government forces, the Government forces do not seem to be thoroughly aligned as yet. At least we do not know of a single system that has had a complete valuation put upon it according to all the edicts of the bill.

After the appointments of the main body of valuation engineers were made, by administrative order all the assistant and minor positions were put under the United States Civil Service Commission. This method does not seem to have worked out satisfactorily in all cases, as the candidates for so-called senior positions were not put through a regular examination, but were "judged and examined" on their service records and the number of articles on technical subjects that they had published. The result of these so-called examinations in some cases were very singular, as men who had never been at the head of their departments were ranked above men who had seen more than twice the service and had been at the head of their departments on two or more railroads. The Civil Service Commission advertised in their circulars that these "senior" positions would pay a certain range of salaries. In some instances when the positions were offered to eligible candidates it was ascertained that there was no intention of paying the higher salaries advertised. This elusiveness caused some candidates to at once become dissatisfied and to state they would decline the positions. This caused dissension at the start and, judging from the slow manner in which the work is being done, this will be long drawn out. Inasmuch as this work is going to cost the people of the country several millions of dollars and the railroads an even larger sum, every effort should be put forth to get the most efficient and quickest results.

When the final physical valuation is obtained—five to seven years from now—it seems that the establishment of a permanent valuation board will be necessary for both the railroads and the Government, if the ultimate object of the law is to be attained. The value of a railroad property will not be the same, from all viewpoints, five years from today as it is at present, in the natural course of development. If rates are to be based on valuation, the change of valuation will be a constant factor to govern the change in rates.

The Interstate Commerce Commission

A YEAR AGO one of our ablest writers on practical railway subjects published a strong article calling attention to the fact that the personnel of the Interstate Commerce Commission did not contain a sufficient number of practical railroad or traffic men. The long drawn out method pursued by this body of arriving at a conclusion in the increased rate case seems to have verified this prophecy and opinion. Onliy last winter, when the present Administration had the names of several men under consideration for appointment to fill the two vacancies then existing on the commission, for the first time two or three representatives raised the question in the House of the advisability of continuing the old policy of appointing attorneys instead of trained railway experts. The objections were futile and half-hearted ,as the two attorneys were appointed. The attention of other representatives was called to this inconsistency and also to the article mentioned above. But "stress of other work" precluded the possibility of their either reading the article or taking a stand against the Administration's appointees. Is it not high time that in a commission of so much power and import men who are experts in the sale of transportation be appointed, rather than have it a goal for political reward to lawyers and others who are not especially versed in this science? The decisions of this commission affect almost every industry in this country, as well as the carrier itself, for the cost of transportation directly affects the cost of manufacture and of produce.

Someone has stated that one of the recent former administrations was contemplating the appointment of one of the best-known railroad executives of the country on the commission. He consulted with one of his advisers, but was informed that although the man under contemplation would be one of the most desirable to be obtained, he could not afford to give up his large interests and salaried connection to accept an appointment that held forth so little monetary remuneration. If this is the situation, it seems proper that the people demand of their representatives that bills be enacted to make this remuneration sufficient to attract men of the highest known ability in transportation matters.

Is not one lawyer well versed in the Federal law as to traffic regulations and one lawyer familiar with Federal restriction as to the amount of bonds and stocks to be issued sufficient representation of the legal profession on the commission? Should not the remaining membership be constituted of a trained traffic man, a transportation official, a representative of manufacturing interests and possibly a representative of produce shippers? Would not this make a commission more representative of general business and the various branches and affiliations of the transportation business? This should be conducive of efficieney and quicker results in reaching momentous decisions. It would obviate the taking of endless testimony, or at least a great deal of it, that now seems necessary to enable the present commission to reach a decision. While these deliberations and taking of testimony are progressing, the business of practically the whole country is affected.

Within the last week an able editorial writer on one of the conservative dailies speaks of the delay of the Interstate Commerce Commission in passing upon the petition of the railroads for an increase of rates as an indictment of the commission itself. During the fourteen months that have passed since the filing of this petition, shippers as well as railroads have been forced to figure in the dark. In addition to orders for railway supplies and most necessary renewals being suspended, quotations upon commodities and produce have been tentative, because of the inability of manufacturers and merchants to figure the cost of transportation.

Bloomingdale Road Track Elevation Project, Chicago C. & C. B. Division, C. M. & St. P. Ry.

Detailed description of design and construction of heavy track elevation work involving the construction of over four miles of concrete walls and thirty-five subways; with interesting data on the economy of bulk cement and concrete plants of different types.

By Albert M. Wolf, C. E.

PART I.

GENERAL DESCRIPTION AND DETAILS OF DESIGN.

General:—One of the large track elevation projects now being carried to completion by the Chicago, Milwaukee and St. Paul Railway is the 2.4 miles of elevation along Bloomingdale Road in the northwest part of the city of Chicago on the C. & C. B. Division, connecting the Evanston Branch with Chicago and Milwaukee Division at Pacific Junction. For this work involving a raise in grade of an average of 17 ft., the building of over four miles of retaining walls and 35 subways, the railroad has made an appropriation of $2,000,000.

The double track line originally was laid in the center of Bloomingdale Road from Dixon Street, where the line crosses the C. & N. W. R. R., to Central Park Avenue near Pacific Junction, with the exception of a portion of the line on private right-of-way between Robey Street and Milwaukee Avenue where Bloomingdale Road does not exist. These tracks were operated under special grant from the city council, the street running through a very poor neighborhood for the most part and not being subjected to very heavy traffic.

In 1910 the railroad company was ordered to elevate its tracks on this street, at the same time the city released its claim to 32 ft. at one side of the street to be occupied by the elevation between concrete retaining walls, in return for which the railroad company was to construct two six ft. sidewalks at each side of the street and pave the remaining 22 ft. between one walk and the elevation with brick. The railroad company was also required to pave all street intersections and subways with granite blocks. These requirements necessitated the relocation of tracks as shown in the accompanying map and profile. (Figure 1.)

Between Ashland Avenue (where the tracks had previously been elevated) and Robey Street the elevation is on the south side of Bloomingdale road with the roadway on the north. At Robey Street is the entrance to the Peterson Street yard, which extends to Hoyne Avenue. Beginning again at Milwaukee Avenue Bloomingdale Road is located on the north side of the elevation and at Humboldt Boulevard shifts to the south of the original street, due to an offset in the street lines. From this point to the end of Bloomingdale Road (or Avenue as it is now called) at Central Park Avenue, the elevation occupies the north portion of the street. Work was started in the spring of 1913 at the east end of the line and also at about the middle near Humboldt Boulevard. At the present time the work is about 80 per cent completed and according to ordinance must be completed by June, 1915.

The project is notable on account of the number of streets which are bridged, no streets being "dead-ended" as is so often the case in track elevation work. The concrete subways which are used in most cases for street crossings represent the most advanced practice in concrete design and will be described in detail.

Retaining Walls.

Typical Walls.—The walls which retain the earth fill at both sides of the right-of-way between street subways are of the gravity type of mass concrete with heights varying from 17 ft. to 19 ft., with an average distance of 32 ft. between faces of walls, except in special cases. The walls have a top width of 1 ft. 6 in., with a heavy coping 1 ft. 6 in. deep projecting 6 in. beyond the face of wall. The front face is vertical, with the plain surface broken by recessed panels about 20 ft. wide, leaving a pilaster about 2 ft. 6 in. wide at the end of each 25-ft. section. These panels relieve the monotony of the plain surface and aid in subordinating the form marks left on the surface.

The back of wall is given a batter of about 5 in. per foot, so that the width at the top of footing varies from 8 to 10 feet, depending on the height of wall. The footings vary in width from 11 to 15 ft., with projections of 2 ft. 6 in. to 4 ft. 6 in. at face and 1 ft. at back of wall. The depth varies from 5 ft. to 2 ft. 6 in., the footings generally being proportioned for a maximum of 4,000 pounds per square foot of soil, as determined

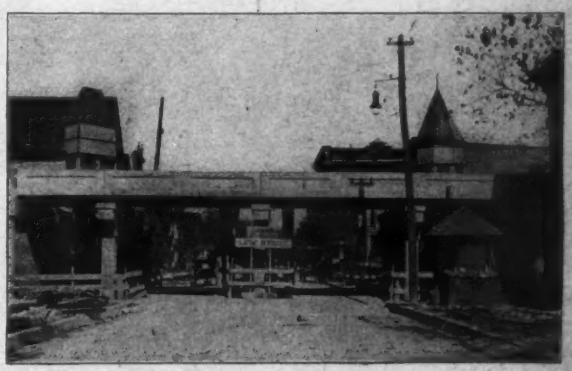


Fig. 2. Typical 60 Ft. Subway—Humboldt St.

from soil tests. The projecting toe of wall is reinforced in the same manner as the toe of abutment footings (described later), with transverse and longitudinal bars to care for the bending moment. Each 25-ft. section of wall is keyed to the other by a wide keyway formed in the end of the previous section.

Special Walls.—Where the clearances would not allow the use of footings projecting some distance beyond the face of wall, a row of piles was driven along the toe to care for the excessive pressure at that point.

At one point where several buildings were very close to the right of way line, mass walls with coping projecting 1 ft. 6 in. and footings the same amount were used, thus preserving the right of way line and at the same time providing an 18-in. space to work in.

Typical Track Elevation Bridges.

General.—In the Bloomingdale Road track elevation work, two types of structures are being used for street crossings or subways. These types can be briefly described as follows: (1) Reinforced concrete subways, consisting of trestle slabs built in place and carried on plain concrete abutments at the street lines and on intermediate skeleton piers of reinforced concrete. These structures are used for practically all crossings except where the angle of skew is very large, in which case the other type is used, viz.: (2) Structural steel bridge with reinforced concrete slab on steel stringers supported by longitudinal girders carried on plain concrete abutments at street lines and intermediate rows of steel columns on concrete footings.

The number of street crossings for which reinforced concrete subways are being used is thirty-two, on the remaining three

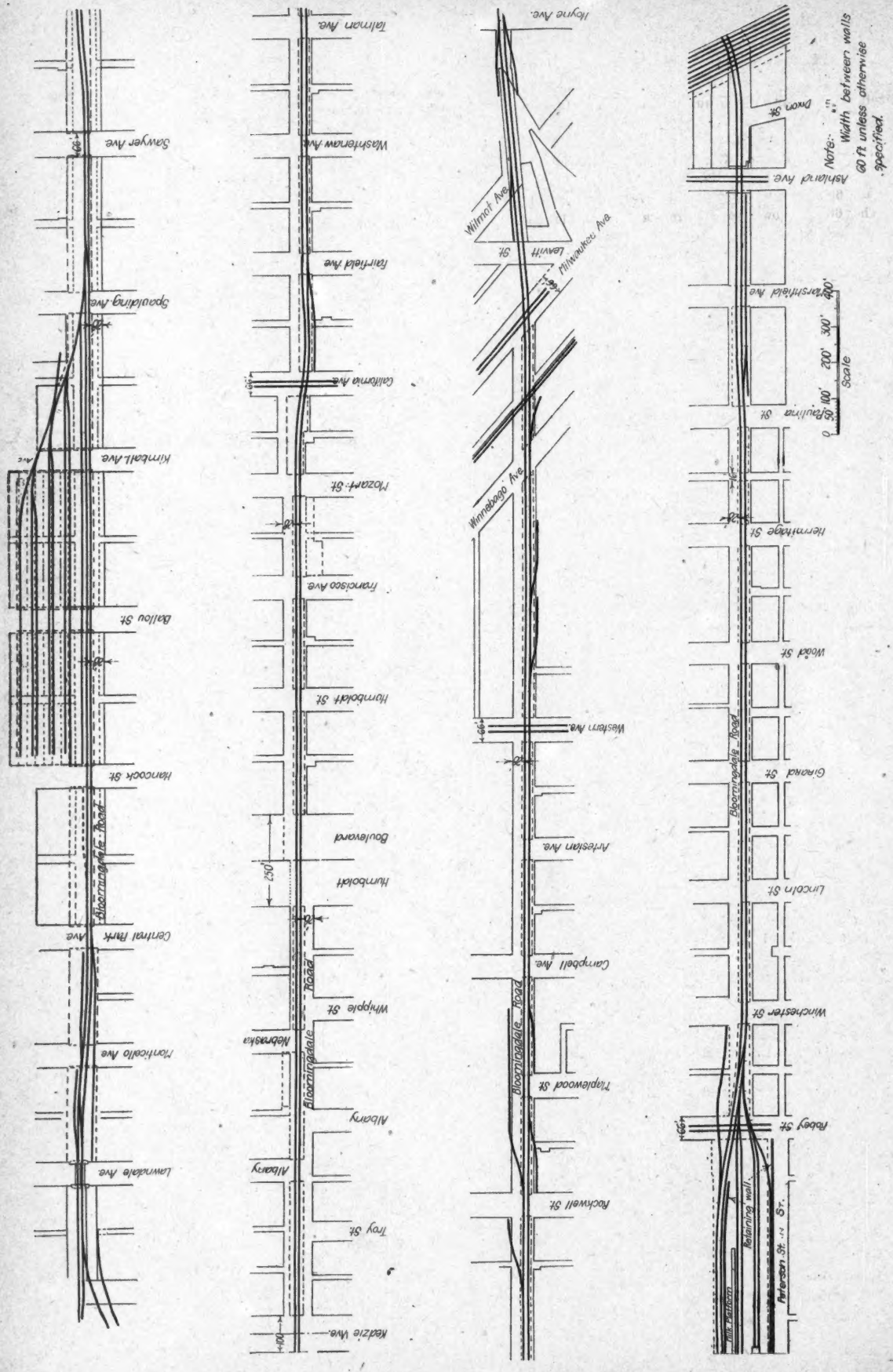


Fig. 1. Bloomingdale Road Track Elevation, C., M. & St. P. Ry.

steel structures are used. Of the former, the standard 60-ft. subway (Figure 2.) is used for twenty-three crossings, as follows: Paulina St., Hermitage Ave., Wood St., Girard St., Lincoln St., Winchester St., Hoyne Ave., Leavitt St., Artesian Ave., Campbell Ave., Maplewood St., Rockwell St., Talman Ave., Washtenaw Ave., Fairfield Ave., Mozart St., Francisco St., Humboldt St., Nebraska St., Albany St., Hancock St., Central Park Ave., and Monticello Ave. Between Spaulding Ave. and Hancock St. a seven-track yard besides the two main line tracks necessitates a slightly wider 60-ft. subway at Spaulding Ave., for three tracks and 60-ft. subways 185 ft. and 221 ft. wide transverse to tracks at Kimball Ave. and Ballou St., respectively.

Standard 66-ft. subways are used at Western Ave. and Sawyer Ave. The 66-ft. subway at California Ave. is located on a curve and has a width of 28 ft. 8 in., while the one at Robey St. is trapezoidal shape in plan, to accommodate several yard lead tracks entering the Peterson St. yard, besides the main line tracks.

At Kedzie Ave. a reinforced concrete subway 100 ft. long is required, while at Humboldt Park Blvd. a special design of concrete subway is used to span the boulevard, 250 ft. wide. This structure, one of the most beautiful track elevation bridges in Chicago, will be fully described in another issue, since lack of space will not permit a description which will do the structure justice in this article.

Structural steel structures are used at Milwaukee Ave. and Winnebago St., on account of the heavy skew (about 45 degrees), to which concrete subways are not especially adapted as far as economy is concerned. The former structure has a length of 66 ft. between abutments, providing for two 10-ft. sidewalks and a 46-ft. roadway, with 13 ft. 6 in. headroom under low steel. The Winnebago St. subway is 60 ft. long with 12-ft. walks and a 36-ft. roadway below, having a clearance of 12 ft.

At Marshfield Ave. a 60-ft. steel subway had to be used because of the fact that for the 12-ft. underclearance required the distance available to base of rail is only 3 ft., which is too shallow for concrete construction for such spans. This structure will be described more in detail later.

All subways for ordinary streets without street car tracks have an underclearance of 12 ft. at the crown of roadway, while for streets with street car tracks a clearance of 13 ft. 6 in. is maintained under the slabs. In practically all cases the existing street grades were lowered very little, if any, and the cost of elevation was therefore materially increased.

Loadings and Stresses Used in Design of Concrete Subways.

The concrete slabs used for concrete subways are known as "trestle or subway slabs," being designed for a minimum of 6 in. of ballast under ties, spanning longitudinally with the track and not being rigidly connected with the substructure. These slabs are designed for the following loads:

Dead Load.—The dead loads considered are concrete weighing 150 pounds per cubic foot and ballast at 100 pounds per cubic foot, the weight of ballast and track being provided for by assuming the ballast to extend to the base of rail.

Live Load.—The live load used in design was Cooper's E-55 loading, with an alternate loading of 125 per cent of a driver load on each of two drivers spaced 7-ft. centers is considered in all cases and used where it produces the greatest stresses. The impact allowed is found by the following formula:

$$\text{Impact} = 0.8 \left\{ \frac{\text{Live Load}}{\text{Live Load plus Dead Load}} \right\} \times \text{Live Load}$$

No impact is considered in design of footings. For the type of slabs used in this work the live load and impact is considered as spread over a width of 13 ft. transverse to track.

The effect of traction is considered in the design of piers and is taken as a longitudinal force of 20 per cent of the live load, applied at the top of rail.

Concrete Mixtures and Stresses.—Concrete of a 1:2½:5 mixture (Class A) is used for footings of piers and abutments. Class AA, 1:2:4 concrete, is used for trestle slabs, bridge seats and copings. Class B concrete, a 1:3:6 mix, is used for heavy mass abutments, walls and unreinforced footings.

The following table gives the principal allowable unit stresses in concrete of various mixtures in pounds per square inch:

Mixture	1:2:4	1:2½:5	1:3:6
Compression, extreme fiber in flexure	700	500	...
Axial compression	450	350	300
Columns fully reinforced with lateral and longitudinal reinforcement	650	...	...
Tension, in extreme fiber	40	30	30
Bearing (concrete section at least twice the loaded area)	650	550	400
Punching shear	120	90	75
Average vertical shear in flexure—			
Without web reinforcement	40	30	...
With full web reinforcement	90	75	...
Bond, deformed bars	100	80	...

$$\frac{E_s}{E_c} = n = 15$$

The allowable unit stress in steel in tension is 16,000 pounds per square inch for main reinforcement and 12,000 pounds per square inch for web reinforcement.

The above unit stresses are increased 20 per cent for stresses due to live load, dead load, impact and traction.

Bearing on Soil.—The allowable unit bearing on soil for all structures on this work was 4,000 pounds per square foot for dead and live loads without impact.

Typical 60-Foot Reinforced Concrete Subway.

General Design.—The Mozart St. Subway, which is typical for the 60-foot reinforced concrete subways, will be described in detail. The structure, 28 ft. wide over all, consists of two street spans, each 19 ft. 6 in. centers, with reinforced concrete slabs 2 ft. 4 in. thick in two sections 14 ft. wide spanning between reinforced concrete skeleton piers, one at center line of street and one at each curb line; and two sidewalk spans of 10 ft. 6 in. from face of abutment to center line of curb piers. These latter slabs have a maximum thickness of 1 ft. 6 in. and are made up in two sections, each 14 ft. wide. The ends of the sidewalk slab rest on plain concrete abutments. All portions of the work were cast in place, but the slabs were poured independent of the substructure. The clearance from crown of roadway to under side of slab is 12 ft., with the base of rail 3 ft. 6 in. above.

Details of Abutments.—The abutments are a modification of the plain gravity type in that the toe of footing which projects 4 ft. 6 in. beyond the face of abutment is reinforced to care for the bending moment produced. This type of abutment is much more stable than the ordinary type with a small toe projection, and in addition avoids excessive toe pressures.

The base of abutment at top of footing is 7 ft. 5 in. wide, or about 0.5 of the height of 15 ft. 6 in. The footing, 4 ft. 6 in. thick, projects 4 ft. 6 in. beyond the neatwork. The toe projection of footing offsets 2 ft. and 2 ft. 6 in. with steps of 2 ft. and 2 ft. 6 in., respectively. At the back of abutment the footing projects only 6 in. The toe of footing is reinforced with ¾-in. deformed square bars 7 ft. long at right angles to abutment face and four ¾-in. bars 1 ft. centers longitudinally. The body of the abutment is keyed to the footing by two 4x12-inch keyways formed in the footings.

The abutment face has a batter of ½ in. to 1 ft, while the back is battered 4½ in. to 1 ft., with two 6-in. recesses, one near top and one near bottom for drain tile. The top of abutment at bridge seat is 2 ft. 7 in. wide, with a coping projecting 5 in., which puts it on line with the neatwork at the top of footing. The bridge seat upon which the deck slabs rest is 3 ft. 6 in. below base of rail and is 1 ft. 2 in. wide, with a 6-in. notch 1 in. deep, into which the slabs are keyed. The bridge seat is reinforced for shear by ½-in. square bars bent in the form of a continuous stirrup (see detail) placed horizontal 3 in. below top. The top of back wall

Fig. 1. Bloomingdale Road Track Elevation, C., M. & St. P. Ry.

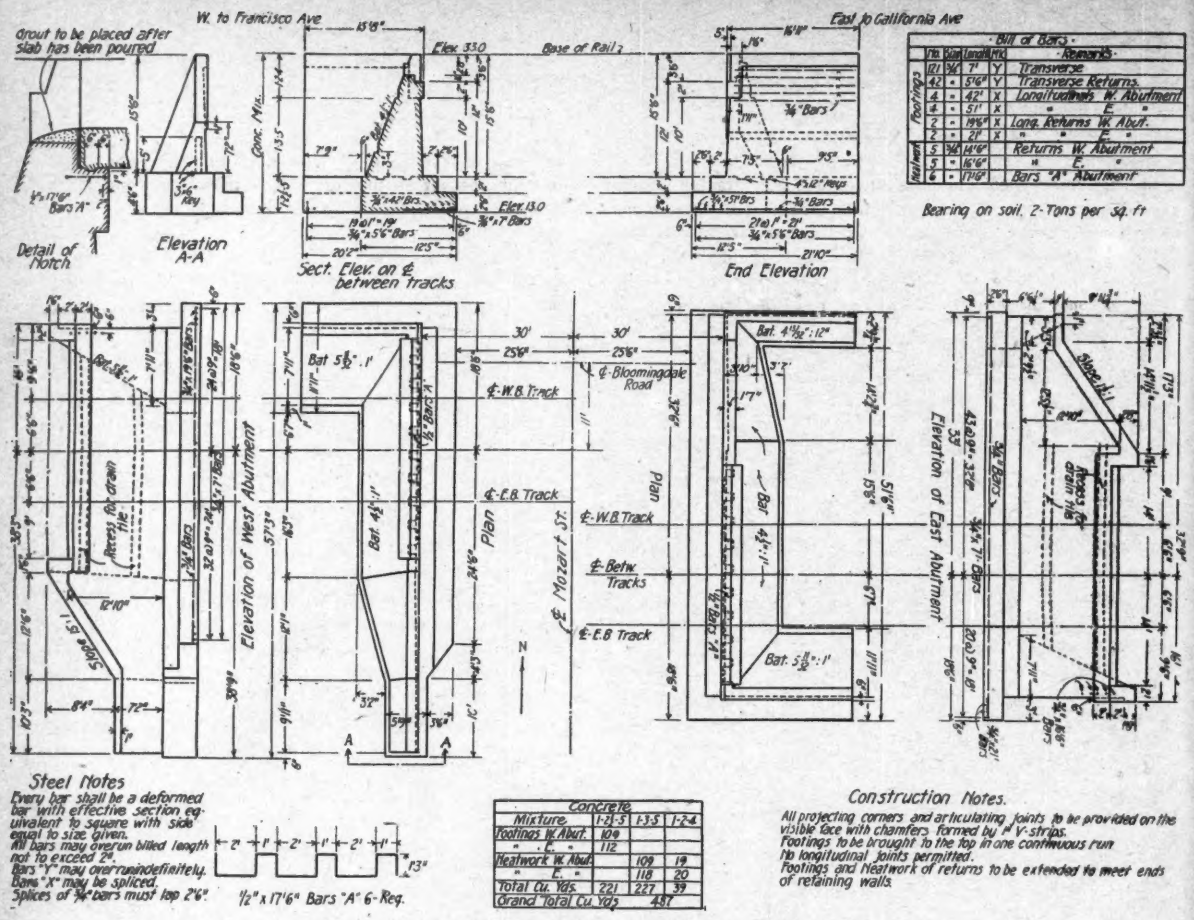

Grout to be placed after slab has been poured
Detail of Notch
Elevation A-A
W. to Francisco Ave
Sect. Elev. on ℄ between tracks
East to California Ave
End Elevation
Bill of Bars
Bearing on soil, 2 Tons per Sq. ft
Elevation of West Abutment
Plan
Elevation of East Abutment
℄ W.B. Track
℄ E.B. Track
℄ Bloomingdale Road
℄ Mozart St.
Steel Notes
Every bar shall be a deformed bar with effective section equivalent to square with side equal to size given.
All bars may overrun billed length not to exceed 2".
Bars "Y" may overrun indefinitely.
Bars "X" may be spliced.
Splices of ¾" bars must lap 2'6".
½" x 17'6" Bars "A" 6-Req.
Concrete
Construction Notes.
All projecting corners and articulating joints to be provided on the visible face with chamfers, formed by ¾" V-strips.
Footings to be brought to the top in one continuous run.
No longitudinal joints permitted.
Footings and Headwork of returns to be extended to meet ends of retaining walls.

Fig. 3. Abutment for 60 Ft. Subway, Typical for All Subways.

of abutment is only 10 in. above the level of the bridge seat, and after the slabs were poured the space between the line of top of slab and top of back wall was grouted as shown in the detail (Figure 3), to facilitate drainage.

The wing walls are returned at right angles with the abutment faces where necessary to meet the retaining walls, which retain the earth-fill between bridges. In such cases the walls are kept the full height to base of rail, with a coping 1 ft. 6 in. deep. Where the earth is allowed to slope away from track at a natural slope the wings extend out in line with face of abutment. Such wings have a top slope of 1½ to 1 until a height of about 7 ft. is reached, which is then maintained to the end of wing. The sloping portion has a coping 18 in. deep, while that of the level portion is 1 ft. deep.

The footings are of a 1:2½:5 mixture of concrete, the body of abutments and wings 1:3:6 concrete reinforced, and the bridge seat and back wall 1:2:4 concrete. Footings were brought to top in one continuous run, no longitudinal joints being permitted. All projecting corners and articulating joints have chamfers formed by 1-in. V-strips on the showing face.

Reinforced Concrete Piers.—The piers for these subways consist of four-column bents 14 ft. 5 in. high, resting on a continuous reinforced footing, the columns being tied together at the top by a continuous girder with an arched underside between columns, to improve the appearance. (See Figure 4.)

The piers have a footing course 27 ft. long and 2 ft. 6 in. deep. The footings for curb piers are 6 ft. 6 in. wide and are reinforced with ¾-in. square bars, 9-in. centers, transversely 3 in. above bottom of footing, and ¾-in. bars, 1-ft. centers, longitudinally just above these. A continuous course of concrete 2 ft. wide and 2 ft. 6 in. deep is keyed to the middle of the main footing course and anchored to the same with ½-in. stirrups. This beam, which with the footing course acts as a continuous inverted T-beam between columns, is reinforced with heavy straight and bent bars and stirrups as shown in Figure 5. The vertical column bars extend through the top part of the footing and lap with stub bars in footing.

The upper course of the center pier is made deeper than that of curb piers, to act as a protection fender for the columns. The depth is 4 ft. 6 in. and the width 2 ft., with the reinforcing placed similar to that in curb footings, and the ends are rounded off to divert into the roadway objects which may strike it.

The four columns of the curb piers are 20x22 in. in cross-section, the latter dimension being measured transverse to track. The intermediate columns are spaced 3 ft. 3 in. to either side of the center line between tracks, and the outer ones 6 ft.

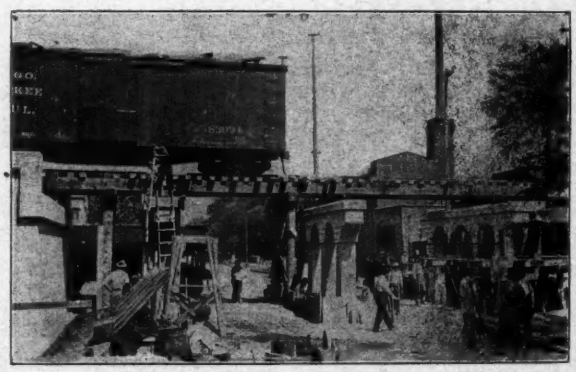


Fig. 4. Reinforced Concrete Piers for 60 Ft. Subway.

6 in. beyond, or 4 ft. 3 in. in from outside face of deck slabs. These columns are reinforced with ten 1-in. square bars extending to top of cross girder on columns and tied together with ½-in. ties spaced 1 ft. centers. At the bottom of columns is a base course 2 ft. high projecting 2 in. beyond face of columns.

The cross girder connecting the top of columns and forming the bridge seat for deck slabs is 2 ft. wide and 2 ft. deep, with circular arched openings of 2 ft. 2 in. radius connecting it to the columns, thus adding materially to the strength and appearance of the structure. A coping 1 ft. deep on top of girder projects 3 in. beyond faces of girder, while the edges of same have a 2-in. bevel. The girder projects 3 ft. 5 in. beyond the center line of outer column to support the lapped 2 ft. 6 in. at splices, and all ½-in. bars for stirrups bent to a 1 in. radius except where otherwise noted.

Subway Deck Slabs.—The subway deck 28 ft. wide overall, consists of eight reinforced concrete slabs in two rows separated from each other by ½-in. joints. The four roadway slabs are 19 ft. 5½ in. long, 13 ft. 11¾ in. wide and 2 ft. 4 in. deep at the center. The sidewalk slabs are 1 ft. 6 in. deep at the center line of pier, with a top slope of 3 in. to the back of abutment. These slabs are 13 ft. 11¾ in. wide and 10 ft. 6 in. long from center line of pier to face of bridge seat coping, with a bearing of a little over 1 ft. on the bridge seat. The slabs have a parapet 3 ft. 6 in. deep overall, cast integral with the same to retain the ballast.

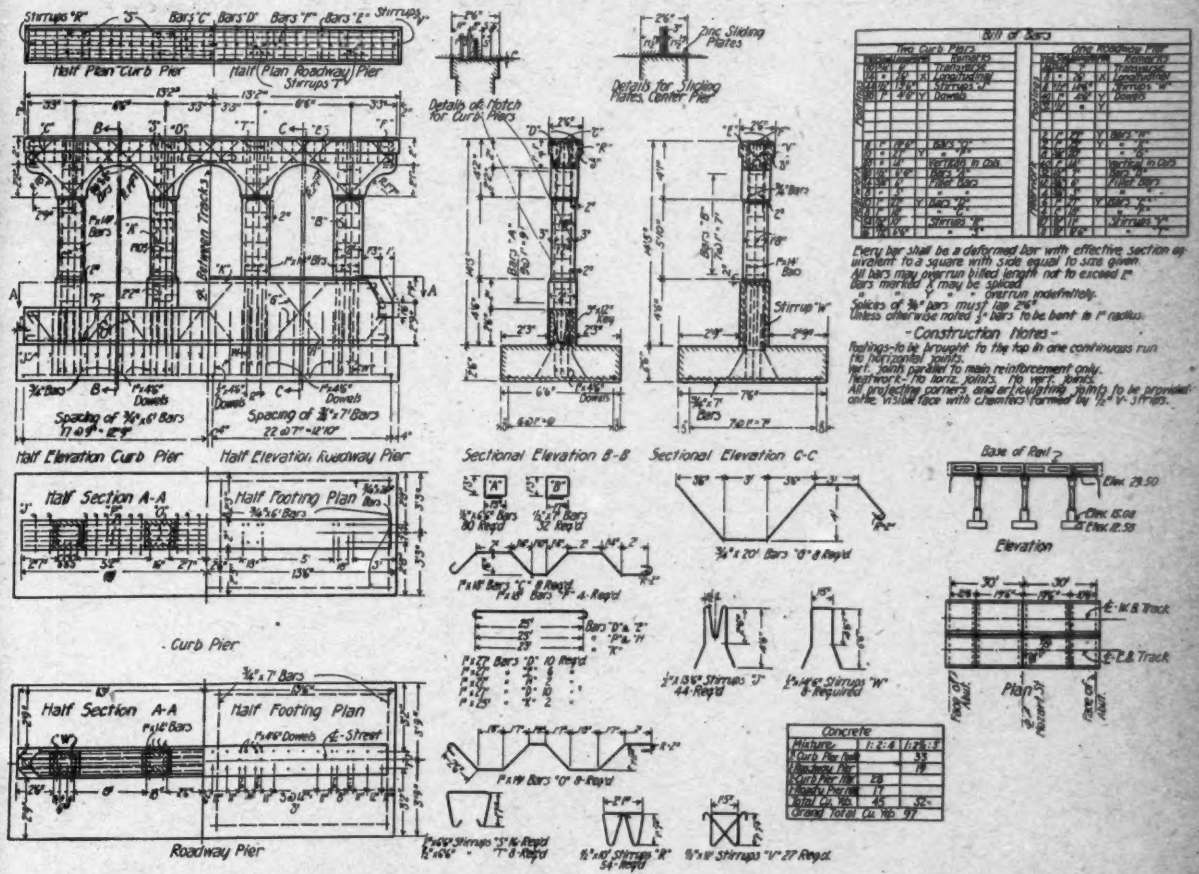

Half Plan Curb Pier
Half Plan Roadway Pier
Half Elevation Curb Pier
Half Elevation Roadway Pier
Sectional Elevation B-B
Sectional Elevation C-C
Half Section A-A
Half Footing Plan
Curb Pier
Half Section A-A
Half Footing Plan
Roadway Pier
Details of Notch for Curb Piers
Details for Sliding Plates, Center Pier
Zinc Sliding Plates
Bill of Bars
Two Curb Piers
Other Roadway Piers
Every bar shall be a deformed bar with effective section equivalent to a square with side equal to size given.
All bars may overrun billed length not to exceed 2".
Bars marked X may be spliced.
" " " overrun indefinitely.
Splices of ¾" bars must lap 2'6".
Unless otherwise noted 1" bars to be bent to 1" radius.
- Construction Notes -
Footings to be brought to the top in one continuous run to horizontal joints.
Vert. joints parallel to main reinforcement only.
Headwork - No horiz. joints. No vert. joints.
All projecting corners and articulating joints to be provided with chamfers formed by ½" V-strips.
Base of Rail
Elevation
Plan
Concrete
Mixture
1:2:4
1:2½:5
Curb Pier
Roadway Pier
Total Cu. Yds.
Grand Total Cu. Yds. 97

Fig. 5. Detail of Reinforced Concrete Piers—60 Ft. Subway, C., M. & St. P. Ry.

outside portion of roadway slab, and has a circular bracket connection to the column. The girder is reinforced as a continuous beam with straight and bent bars in top and bottom, with stirrups to take the shear in excess of 40 pounds per square inch. The fillets are reinforced with two ¾-inch bars 6 ft. long placed at 45 degrees.

The columns of center pier are 20x24 inches in cross-section and are otherwise the same as curb pier columns, the cross girder connecting them at the top being the same as that just described.

At the top of the center pier are placed zinc sliding plates to form a sliding joint for the slabs, while the curb piers are provided with 4-in. notches 1 in. deep to key the slabs to them and thus fix the ends.

The footings are of a 1:2½:5 mixture of concrete, while all other concrete is 1:2:4. The three piers contain 97 cubic yards of concrete. All projecting corners and articulating joints have chamfers formed by ½-in. V-strips on all showing faces. All bars used were deformed squares, ¾-in. bars being

Roadway Slabs.—The roadway slabs are 2 ft. 4 in. thick at the center, with a slope of 2 in. for drainage to the side gutters, which have a slope of 3 in. from center pier to end of slab over curb pier where they discharge onto the sidewalk slabs, which slope back to abutment, as stated above. At the center line of bridge, where the slabs join, is a longitudinal curb wall 6 in. wide and 4 in. high, to prevent seepage and drainage from entering the longitudinal joint between slabs.

The main reinforcement consists of 1 in. square bars 19 ft. long in two layers at a spacing of 3½ in. centers, staggered.

The centers of bottom bars are 2 in. above bottom of slab, with a distance of 1¾-in. centers between layers of bars. Distributing bars, ¾ in. square by 13 ft., are spaced 2-ft. centers transversely between the two layers of main bars, and also in the top of the slab just below the longitudinal bars in top, three of which are used at 21-in. spacing at either side of center line of track and two at the edges.

All web reinforcement is provided in the form of stirrups, no bent bars being used. The transverse spacing of prongs of

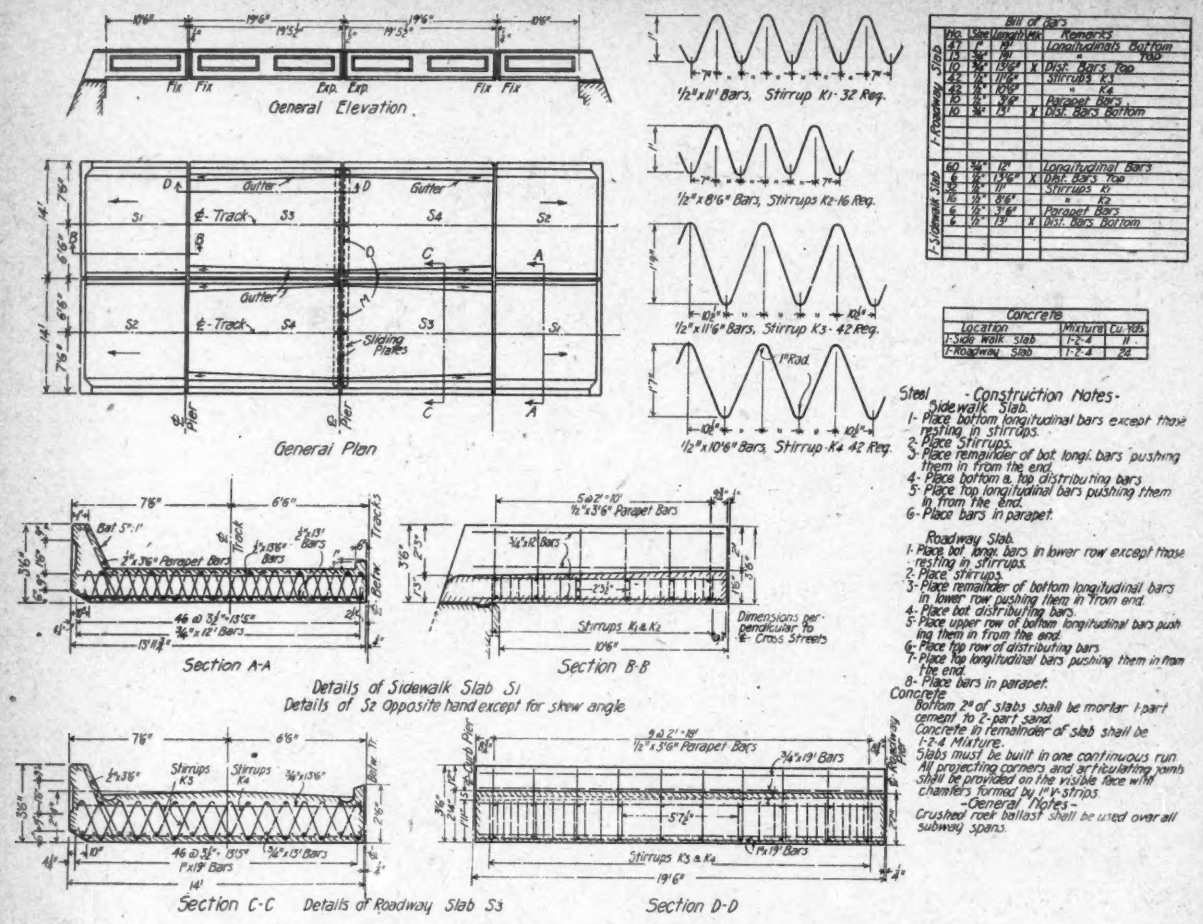


Fig 6. Reinforced Concrete Slabs—Typical 60 Ft. Subway, C., M. & St. P. Ry.

the continuous loop stirrups used is made the same throughout the slab, the difference in amounts of steel required being taken care of by the transverse spacing of the stirrups. The stirrups are made in continuous triangular loops for full width of slab, as shown in the detail (Figure 6), so as to support the longitudinal bars. Alternate rows of the stirrups are inverted and the depth reduced so that some of the upper layer of bars are supported in the loops. The stirrup spacing is varied as shown, from 4 in. to 1 ft. at about the third point of slab span.

The parapet formed on the outer edge of the slab is 3 ft. 6 in. deep over all, with a top width of 1 ft. and a back batter of 5 in. to 1 ft. to the top of slab. At a point 9 in. below top of parapet, panels 2 in. deep, 1 ft. 6 in. wide and 7 ft. 9 in. long are formed in the same to relieve the monotony of the plain surface. The bottom edge of parapet is beveled off 6 in. in 10 in., thus apparently reducing the depth 6 in. The reinforcement of parapet consists of two ¾-in. bars in top and ½-in. by 3-ft. 6-in. stub bars at 2-ft. centers anchoring same to the slab.

Sidewalk Slabs.—As previously stated the sidewalk slabs are given a slope toward the abutment instead of toward sides of slab, the gutter being dispensed with; the 4x6-in. curb at inside edge, however, is used, same as for roadway slabs.

The main reinforcement consists of one layer of ¾-in. by 12-ft. bars longitudinal at 3½-in. spacing, centers of bars being two inches above bottom of slab. A few longitudinal bars are also used in the top of slab. Transverse distributing bars ½ in. square are placed just above the main longitudinal bars and just below those in top of slab, at a spacing of 2-ft. centers. The web reinforcement is in the form of stirrups of the same type as those used in roadway slabs. The parapet wall is detailed the same as that of roadway slabs except that only one panel is used, as against two for the longer slabs.

Construction Details.—The slabs were constructed of 1:2:4 concrete, and each slab was poured in one continuous run. The roadway slabs contain 24 cubic yards of concrete each and the sidewalk slabs 11 cubic yards each. The bottom 2 inches of all slabs are of a 1:2 cement mortar, to insure adequate covering of bars, which would be difficult in view of the close spacing of main bars. All projecting corners and articulating joints on showing faces were given a chamfer formed by a 1-inch V-strip.

The slabs rest on sliding plates on the center pier, thus forming an expansion joint, all other bearings being "fixed," as later described. These zinc plates extend over the entire bearing area and are bonded to the bottom of slabs. The "fixed" bearings are formed by the concrete of slabs entering the keyways left in the tops of piers and bridge seat of abutment. The joints between slabs at "fixed ends" are filled with cement, while the expansion joint over sliding bearing is filled with sheets of waterproof "Lith" 1 inch thick. These sheets will compress to about one-fourth of their thickness and are therefore very effective as expansion joint fillers.

Waterproofing.—Before applying waterproofing to the slabs all recesses and re-entrant angles or pockets in the surface of concrete are filled with cement mortar and all sharp corners rounded off. All open construction joints are filled with cement mortar, the expansion joints between slabs, however, are carefully cleaned out to allow free movement. The concrete surface is then thoroughly cleaned with wire brushes, care being exercised to remove all laitance. If necessary, hot sand is used to dry out all corners, gutters, etc.; since it is absolutely essential to have the surface dry. The deck is then mopped with hot pitch and Barrett's Specification five-ply waterproofing applied, the layers of felt being laid with wide laps and covered with hot pitch.

Wherever practicable the waterproofing is laid in one run for the full width, transverse to the drain slope, and both ends dashed into recesses in curbs and parapets. Longitudinal joints where necessary are made at the center line of slabs, if possible. The ½-inch expansion joints between slabs are covered with two continuous strips of tar paper 3 feet wide, care being exercised to prevent any pitch getting between layers. The top layer of paper is then mopped with hot pitch and the waterproofing carried over it in the same manner as if no joint existed. At fixed ends of slabs the joints are filled with cement mortar before waterproofing.

The waterproofing is covered with a 1½-inch layer of 1:2:3 concrete with ½-inch stone or gravel for coarse aggregate as soon as it becomes cold. This covering of concrete is troweled smooth and the surface protected from the direct rays of sun for 24 hours after finishing. The stone ballast is spread on the deck as soon as the concrete has hardened.

Details of 66-Foot Subways.

General.—The 66-ft. subways at Sawyer Ave. and Western Ave., are of the same general design as the 60-ft. subway just described, except that the roadway spans are 24 ft. 6 in. center to center of piers and the sidewalk spans 8 ft. 6 in. center of pier to face of abutment. The underclearance at the crown of roadway is 12 ft. at Sawyer Ave. and 13 ft. 6 in. at Western Ave., with a distance of 4 ft. 1 in. to the base of rail. The main slabs, on account of the longer span, have a maximum depth of 2 ft. 11 in.

Abutments and Piers.—The abutments and piers are of the same general design as those just described, and therefore will not be described in detail here. The details of piers which are of somewhat heavier construction on account of the longer span.

Slabs.—Eight reinforced concrete slabs make up the roadway deck, which is 28 ft. wide. The four roadway slabs, 13 ft. 11¾ in. by 24 ft. 5½ in., are 2 ft. 11 in. thick at the center, with a main reinforcement in bottom of slab, consisting of 1 in. square bars in two layers at a spacing of 2¾ in., staggered. The other details of reinforcement and drainage of slabs are substantially the same as those for slabs for 60-ft. subways; the parapets, however, have a greater over-all depth, viz., 4 ft. 1 in., the height above top of slab being kept 1 ft. 2 in.

The sidewalk slabs, with a span of 8 ft. 6 in. from center line of pier to face of abutment, are 1 ft. 5 in. thick over the pier and 1 ft. 2 in. over abutment, to provide drainage. The main reinforcement consists of ¾-in. bars, 5-in. centers, with other details as for 60-ft. subway sidewalk spans. Each sidewalk slab contains 8 cubic yards of concrete, while the roadway slabs require 39 cubic yards.

Construction Details.—The methods of construction do not differ from those just described, except that at Western Ave. the construction of the foundation for center pier is such as to bridge over an 8-foot brick sewer a few feet below street grade. This is to be accomplished by supporting the center pier on a continuous grillage of I-beams encased in concrete over the sewer, carried on two continuous footings parallel to pier, on each side of sewer. Each of these footings will be carried on two rows of wood piles, to guard as much as possible against any unequal settlement which might take place.

Construction Feature—California Ave. Concrete Subway.

In constructing the 66-ft. concrete subway at California Ave. a different method of construction of the deck slabs had to be used from that ordinarily used on the other structures. Instead of casting the slabs in their final position on the piers they were cast on forms raised some distance above top of piers and afterwards let down into place. (See Fig. 7.)

This method of construction had to be used, since it was necessary to keep the two street car lines open for traffic as much of the time as possible. With this end in view, after the piers had been built the slab forms for one of the roadway spans were erected on blocking and the concrete poured without interrupting traffic. Then after the slab had cured sufficiently to warrant its being lowered into place safely, the street car track was torn up and the street excavated to the required depth for new clearance requirements, the slab lowered, and the car track replaced. While this work, which required only a few days, was being carried on, all street car traffic was diverted to the other track at either side of the subway. After one roadway span had been completed the other was constructed in a similar manner.

Kedzie Ave. Subway.

The Kedzie Ave. subway, 100 ft. long between abutments and 28 ft. wide, is composed of three main spans of 24 ft. each and two sidewalk spans of 14 ft. The intermediate slabs rest on reinforced concrete piers of the typical design previously described, and the outer ends of sidewalk slabs are carried on gravity abutments of the same type as used for 60-ft. subways. The two outer main spans are over the roadways, with a clearance of about 13 ft. from crown to under side of slabs, while the middle slab spans the parkway between drives. The total distance from under side of slab to base of

Fig. 7. California Ave. Subway Showing Slabs Resting on Blocking to Allow Street Car Clearance.

rail is 4 ft. 3½ in., which is also the depth of the parapets of slabs.

The reinforced concrete slabs for this structure differ from those of 60-ft. and 66-ft. subways in that some bent bars are used for main reinforcement, the other reinforcement being about the same. The roadway span slabs are 23 ft. 11½ in. long and 13 ft. 11¾ in. wide, a depth of 2 ft. 9 in. at the center and 2 ft. 7 in. at sides. The main reinforcement consists of two layers of 1 in. square bars at 6-in. centers, the top layer being straight and the bottom layer alternate straight and bent bars, the latter being bent at both ends, thus providing shear reinforcement in addition to the stirrups which are used at end portions. The parkway slabs are same as roadway slabs except that they have a longitudinal slope of 2 in. from center for drainage onto the roadway slabs, which drain to gutters at the sides. The sidewalk slabs are 1 ft. 10 in. deep over pier and 1 ft. 8 in. at abutments, main reinforcement consisting of 1 in. square bars alternate bent and straight at 4¾-in. spacing; stirrups and transverse bars are also used, as shown in Figure 8. The sidewalk slabs each contain 17 cubic yards, the roadway slabs 35 cubic yards, and the parkway slabs 37.5 cubic yards of 1:2:4 concrete.

Marshfield Ave. Subway.

General.—The Marshfield Ave. Subway is a steel structure consisting of four lines of longitudinal through girders carried on three intermediate transverse column bents and concrete abutments at ends, with a reinforced concrete floor supported on transverse I-beams between girders. The bridge 63 ft. 7 in. long, out to out, and 39 ft. wide center to center of side girders, has a concrete sidewalk carried on cantilever brackets 4 ft. 1 in. long on one of the outer girders. (See Figure 9.)

Loadings and Stresses.—The loadings used in design were the

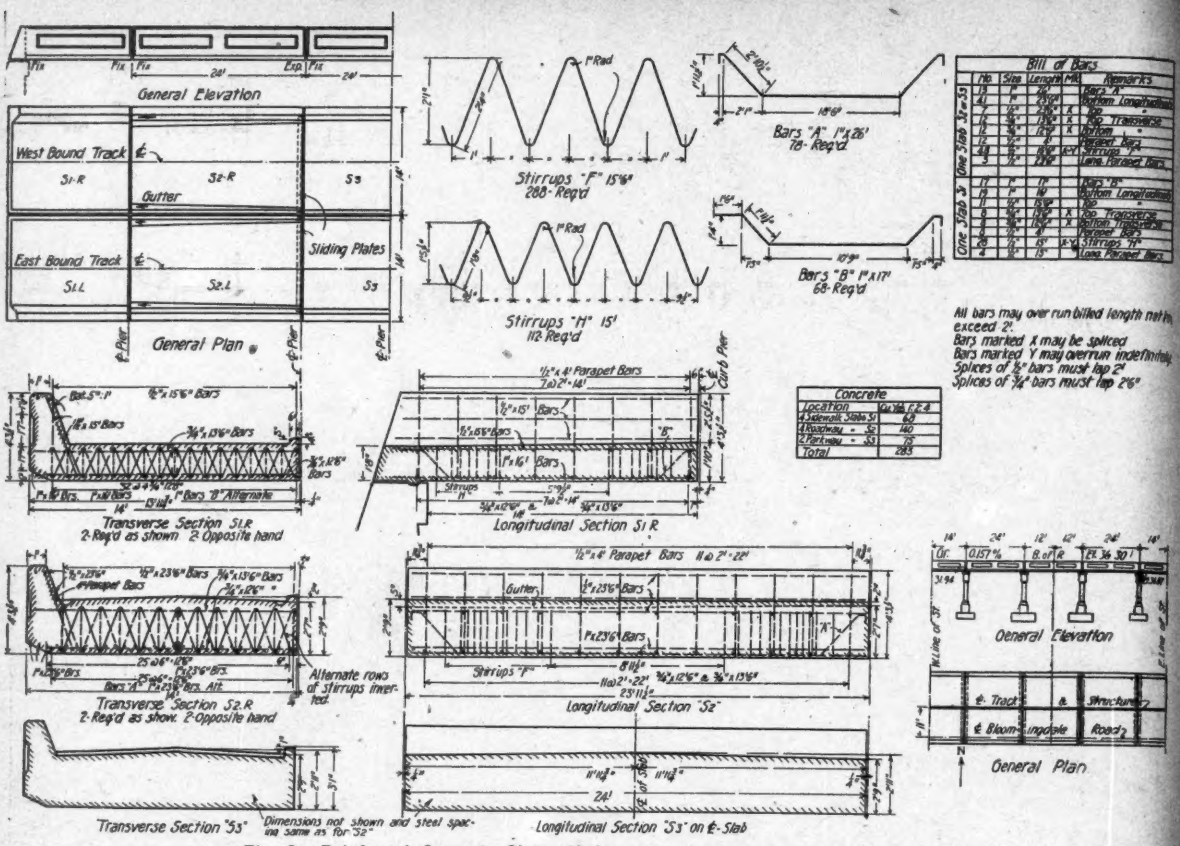

General Elevation
West Bound Track
East Bound Track
Gutter
Sliding Plates
General Plan
Transverse Section S1.R
Transverse Section S2.R
Transverse Section "S3"
Longitudinal Section S1.R
Longitudinal Section "S2"
Longitudinal Section "S3" on ℄ Slab
Stirrups "F" 15'6" 288 Req'd
Bars "A" 1"x26' 78 Req'd
Stirrups "H" 15' 112 Req'd
Bars "B" 1"x17' 68 Req'd
Bill of Bars
Concrete
Location
Total
All bars may over run billed lengths not to exceed 2".
Bars marked X may be spliced
Bars marked Y may overrun indefinitely
Splices of ½" bars must lap 2'
Splices of ¾" bars must lap 2'6"
Alternate rows of stirrups inverted.
Dimensions not shown and steel spacing same as for "S2"
General Elevation
General Plan

Fig. 8. Reinforced Concrete Slabs, Kedzie Ave. Subway, C., M. & St. P. Ry.

same as for concrete subways. The unit stresses governing the design were: steel in tension, 16,000 pounds per square inch; steel in compression, columns, $16{,}000 - 70\frac{l}{r}$ pounds per square inch; shear on plate girder webs, 10,000 pounds per square inch on gross section; bearing on concrete under base plates of columns and girders at abutments, 600 pounds per square inch. Bearing on soil under abutments and piers, 4,000 pounds per square foot.

Abutments and Column Footings.—The abutments are of the gravity type with reinforced toe, same as used for concrete subways. The footings for intermediate column bents are reinforced concrete spread footings designed as continuous beams between the steel columns. The footing for roadway columns is 6 ft. 6 in. wide, 45 ft. long and 3 ft. thick, with a top course 3 ft. wide and 1 ft. 7½ in. deep, upon which the columns rest. The reinforcement consists of straight and bent bars longitudinally, so arranged as to properly reinforce all regions of tension. (See Figure 10.) Transverse distributing bars are used in bottom of slab and stirrups are provided at column location to provide for shear in excess of 40 pounds per square inch. Four 1¼-in. anchor bolts are embedded in the concrete at each column base for anchoring the same.

The curb column footings are 4 ft. 6 in. wide, 45 ft. long and 3 ft. thick, with pedestals 2 ft. 6 in. x 3 ft. and 1 ft. 7½ in. high under each column. These footings are reinforced in a similar manner to that of roadway columns. The tops of pedestals are 7½ in. above crown of roadway.

Superstructure.—The main girders are carried on the top of steel columns tied together transversely at the top just below main girders by lattice portal bracing. The outer columns consist of two 15-in. 33-lb. channels, laced together at 1-ft. 7½-in. back to back. The two intermediate columns of each bent are of considerably heavier section, being of a built-up I-section, composed of four 5x3½x⅜-in. angles, one 12-in. x ⅜-in. web plate and two 15-in. 50-lb. channels for covers. The flange angles are placed 1 ft. ¾-in. back to back, and the legs of channels are tied together with battens between top and bottom plates. The details of columns are shown in Figure 11.

The longitudinal girders are of a uniform depth of 3 ft. 6½ in. back to back of angles, the difference in required strength of the various girders being obtained by changing web and flange sections. The main intermediate girders have 42-in. x ⅝-in. webs with 6 x 6 x ½ in. flange angles, and 14-in. x ½-in. cover plates. Stiffener angles are so arranged that alternate stringers, which are spaced 1 ft. 4 in. centers, connect to outstanding legs, the other stringers framing into the web of girder. At

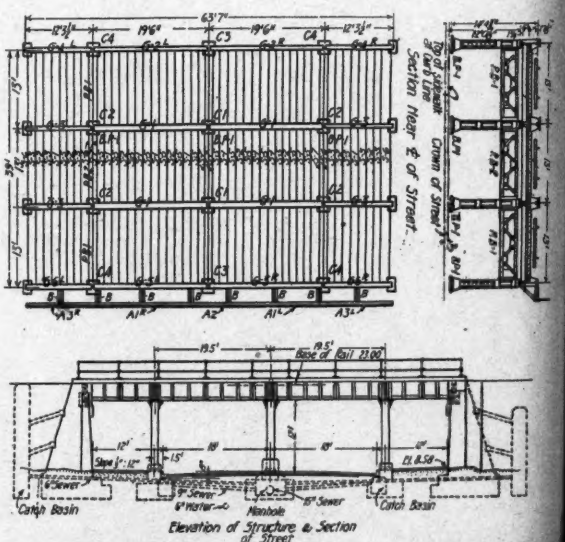


Fig. 9. Plan and Elevation, Marshfield Ave. Subway.

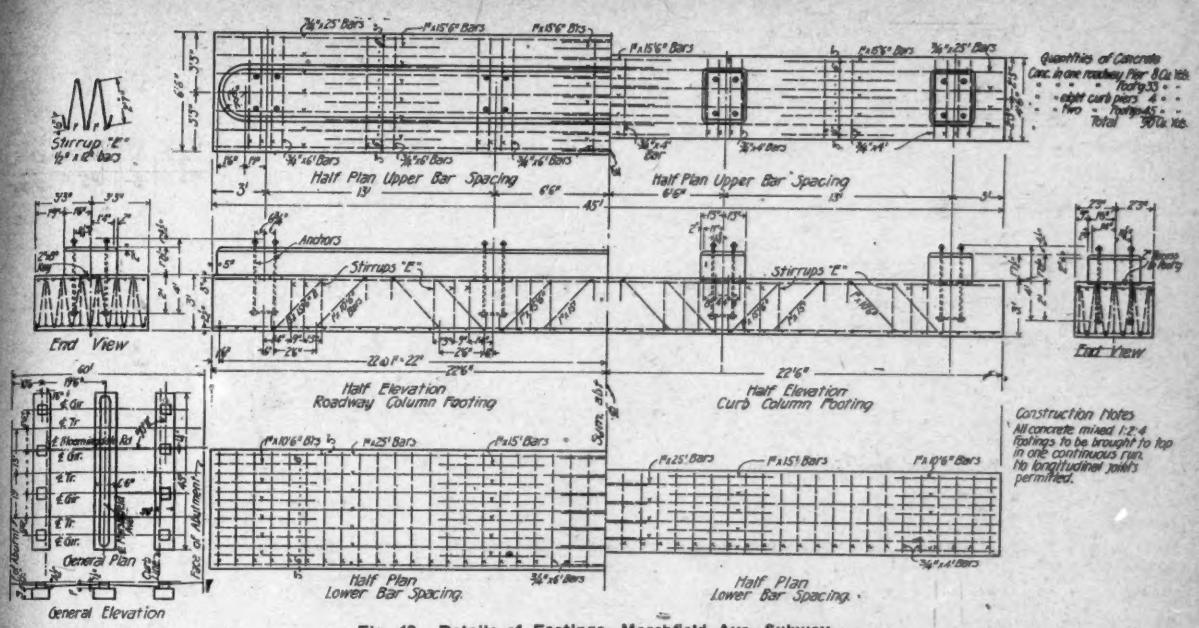

Stirrup "E"
Half Plan Upper Bar Spacing
Half Plan Upper Bar Spacing
Quantities of Concrete
Conc. in one roadway Pier 8 Cu. Yds.
" " " footings 33 " "
" " eight curb piers 4 " "
" " two " footings 45 " "
Total 90 Cu. Yds.
Anchors
Stirrups "E"
Stirrups "E"
End View
End View
Half Elevation Roadway Column Footing
Half Elevation Curb Column Footing
Construction Notes
All concrete mixed 1:2:4
Footings to be brought to top in one continuous run.
No longitudinal joints permitted.
General Plan
Half Plan Lower Bar Spacing.
Half Plan Lower Bar Spacing.
General Elevation

Fig. 10. Details of Footings, Marshfield Ave. Subway.

alternate stiffeners a bracket is connected to the main girder and stringer to stiffen the upper portion of the girder. The 15-in. 42-lb. I-beam stringers frame into girders close to bottom of same, so as to produce as shallow a floor as possible. The details of some of the girders are shown in Fig. 12.

To retain the ballast the I-beams are covered with a reinforced concrete slab 8 in. thick at middle of bridge, sloping to 5½ in. thick at ends over abutments to provide for drainage. The bottom of slab is 2 in. below top of I-beams, the main bars resting directly on the flanges of I-beams. The reinforcement transverse to I-beams consists of ⅜-in. diameter bars, 3½-in. centers in bottom and 7½-in. centers in top, with ⅜-in. bars transverse in bottom at 1-ft. 4-in. spacing. At the middle of the bridge an expansion joint extends across the entire slab. The

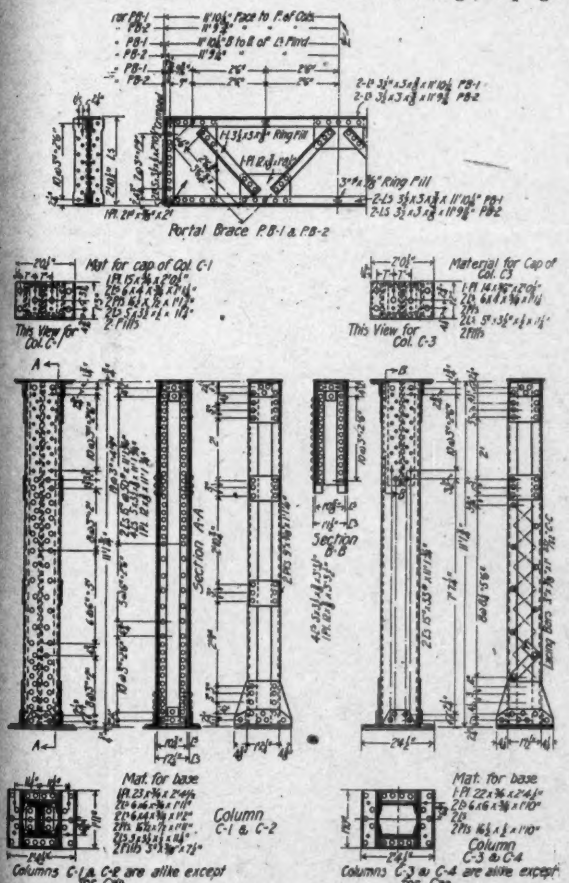

Portal Brace P.B-1 & P.B-2
Mat. for cap of Col. C-1
This View for Col. C-1
Material for Cap of Col. C-3
This View for Col. C-3
Section A-A
Section B-B
Mat. for base
Column C-1 & C-2
Columns C-1 & C-2 are alike except for Cap.
Mat. for base
Column C-3 & C-4
Columns C-3 & C-4 are alike except for Cap.

Fig. 11. Details of Columns, Marshfield Ave. Subway.

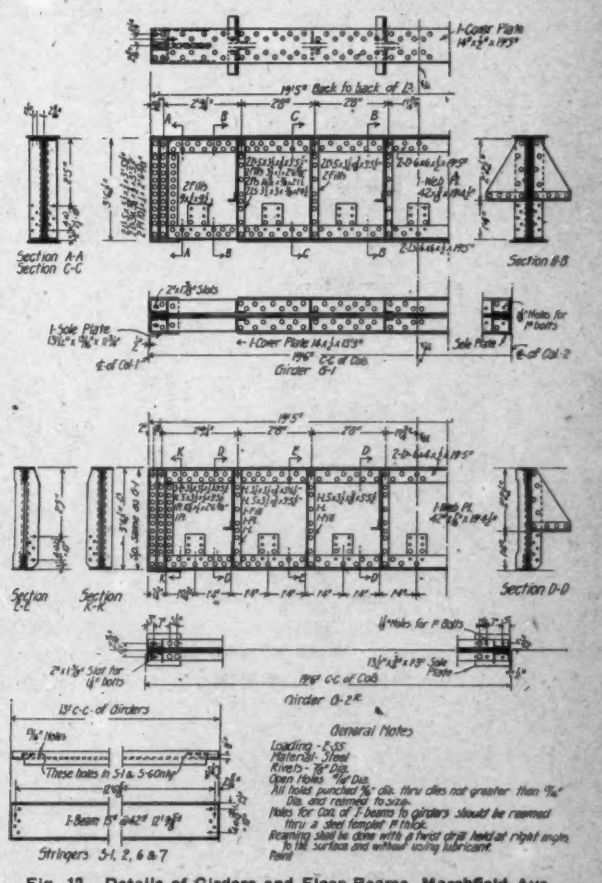

I-Cover Plate
19'5" Back to back of I3
Section A-A
Section C-C
Section B-B
I-Sole Plate
I-Lower Plate
Girder G-1
Section E-E
Section K-K
Section D-D
Girder G-2
13' C-C of Girders
General Notes
Loading - E-55
Material - Steel
Rivets - ⅞" Dia.
Open Holes - 1" Dia.
All holes punched ⅞" dia. thru dies not greater than 15/16" Dia. and reamed to size.
Holes for Col. of I-beams to girders should be reamed thru a steel templet ½" thick.
Reaming shall be done with a twist drill held at right angle to the surface and without using lubricant.
Paint
These holes in S-1 & S-6 Only
I-Beam 15" @ 42#
Stringers S-1, 2, 6 & 7

Fig. 12. Details of Girders and Floor Beams, Marshfield Ave. Subway.

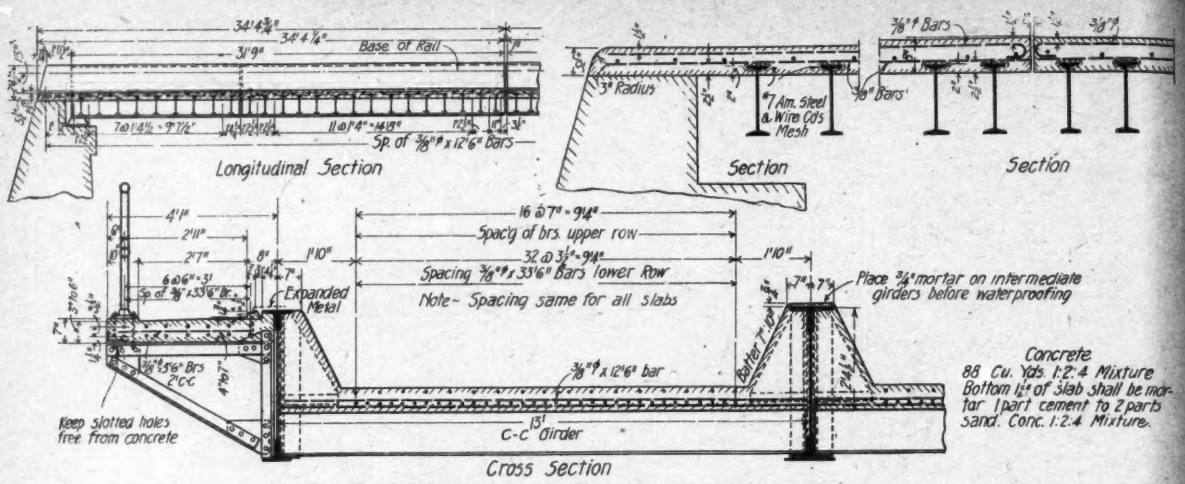

Longitudinal Section
Base of Rail
Sp. of 3/8"ϕ x 12'6" Bars
Section
3" Radius
7" Am. Steel & Wire Co's Mesh
3/8"ϕ Bars
Section
Spacing of brs. upper row
Spacing 3/8"ϕ x 33'6" Bars lower Row
Note- Spacing same for all slabs
Expanded Metal
Place 3/4" mortar on intermediate girders before waterproofing
Concrete
88 Cu. Yds. 1:2:4 Mixture
Bottom 1/2" of Slab shall be mortar 1 part cement to 2 parts sand. Conc. 1:2:4 Mixture.
3/8"ϕ x 12'6" bar
Keep slotted holes free from concrete
C-C Girder
Cross Section

Fig. 13. Reinforced Concrete Floor Slab, Marshfield Ave Subway.

concrete is carried up to tops of girders, as shown in the cross-section (Fig. 13), so as to facilitate waterproofing, which is applied in the same manner as for concrete subways.

The Winnebago St. and Milwaukee Ave. subways are of the same general type of construction as the Marshfield Ave. structure, but are, of course, somewhat more complicated on account of the heavy skew.

Special Subways.

Industrial Track Structure.—At Robey St. a special single track structure for an industrial track is being built to the north of the main subway. This subway is of the same type of design as the 66-foot subways, except that it was designed for a lighter loading.

The piers consist of two-column bents and the slabs which are 13 ft. wide over parapets, are being cast in one section from parapet to parapet.

Alley Subway—Between Paulina St. and Hermitage Ave. an alley subway 16 ft. wide, with a clearance of 12 ft., has been provided for the accommodation of a nearby industry, which company pays the cost of construction.

Elevated Yards.

Between Robey St. and Hoyne Ave., bounded on the south by Peterson St., is a five-track team yard, about 600 ft. long. The main line tracks on the north will be separated from the yard by a ramp wall, the yard being at a lower level. This yard has not yet been built, the Robey St. subway, which forms the approach, being under construction at the present time.

The Ballou St. yard is about 250 ft. wide and 1,250 ft. long from the beginning of lead on ladder track at Spaulding Ave. to the end of yard at Hancock St. This yard consists of eight tracks and four driveways, the middle six being arranged in pairs, at 12 ft. centers, with 36 ft. to center line of first track in the adjacent pair, and to the outer tracks at north and south side. This yard is carried over Kimball and Ballou Sts. on concrete subways extending the full width of yard, the deck slabs being set side by side without open space between tracks. Nearly all ground for this yard had to be purchased by the railroad company.

Sidewalks and Pavements.

As previously stated, the railroad company is required to build 6-ft. concrete sidewalks at both sides of Bloomingdale Road, and at all street crossings. All subways are to be paved with granite block on concrete base, with combination concrete curb and gutter. The portion of Bloomingdale Road not occupied by railroad will be paved with brick on concrete base, roadway to be 22 ft. wide, with a 6-ft. walk. The brick and granite blocks are set with a bituminous filler.

Fences.

Where alleys which dead end on the side of right of way upon which the 6-ft. walk is located, a turning space 25 ft. wide had to be provided by the railroad company for all alleys less than 24 ft. wide, this land being acquired from the abutting property owners. To prevent teams from driving on the walk, concrete posts were set along inside edge of sidewalk at about 4 ft. centers, thus allowing free passage of pedestrians, but effectually shutting out teams. These posts, 8 ft. long, about 4 ft. of which is above ground, are tapered from about 9 in. square at the butt to 6 in. square at the top, reinforced with bars in each corner.

At points where additional property has been acquired the same is fenced with a high wire fence, carried on concrete posts of T-section, with rounded stem.

PART II.

METHODS OF CONSTRUCTION.

Excavation.—The excavation for footings of retaining walls was done by a ditcher traveling on track laid in sections on the line of trench. As the trench was excavated the ditcher backed up on its track and one of the portable sections of track was lifted by means of the boom and laid down ahead of the ditcher. The excavated material was loaded into cars and used for filling at other points where same could be dumped without interfering with operations.

The excavations for footings of piers and abutments were made by hand, the earth being thrown back between retaining walls, which were built before the subways were started.

Concrete Plants.—In this work various types of equipment for the economic handling and distribution of concrete are being used. The construction trains include ordinary concrete plants mounted on flat cars, the concrete being distributed by means of gravity chutes; and plants in which the concrete is distributed by locomotive crane and tower distributing systems. One outfit is especially interesting as regards the methods of handling materials from cars to mixer. In this case instead of transferring materials to the mixer by wheeling them along runways placed on the tops of cars, as is done on all other trains, a drag-line bucket operated on a cableway is used to pick up the sand and gravel from the cars and transfer them to the receiving bins on the mixer car. In addition to economy being effected by the types of construction plant used, the costs of concrete work have also been reduced by the use of bulk cement. All mixing cars built by the railroad company are equipped with ½-yard mixers. The charging platforms and approaches are unencumbered when bulk cement is used and the wheelers have unobstructed access to the charging hopper.

The train crews for the different plants vary from 35 men

down to one-third that number for the drag-line plant. The outputs of the different types of trains used on the several kinds of work usually exceed the set standard of 150 yards per day and in some cases exceed 200 yards with the more improved methods.

Concrete Plants for Wall Footings.—The footings for retaining walls which are poured in 25-ft. sections, are concreted with ordinary plants with a simple gravity chute swing from an outrigger attached to the mixer car. The sand and gravel are wheeled along runways on the top of gondolas and the cement taken from box cars ahead of the mixer is wheeled of car. The equipment shown in Fig. 14 with a ½-yard mixer, is used to pour footings for retaining walls at either side of the right of way, and has a capacity of four or five 25-ft. sections in one day, with a crew made up as follows:

2 cement wheelers.
2 cement loaders.
2 men on charging platform.
2 men at the chute.
24 (approx.) sand and gravel wheelers.
1 engineer.
1 sub-foreman.
2 or 3 men on forms.

One ½-yard batch of concrete is produced by such a plant per minute, and 140 to 150 yards per day is found to be an easy output at the charging platform by using bulk cement, and when possible to do so, locating the cement car next to the mixer, and at the head of the train makes the reduction to two cement wheelers possible.

Concrete Plants for Retaining Wall Construction.—The retaining walls being constructed on both sides of right of way before any elevating was done, necessitated the use of such concrete plants as could elevate the concrete 15 or 20 ft. to the tops of wall forms. A locomotive crane and a ditcher with ½-yard buckets on booms were used for this work, also a self-contained tower distributing plant.

The former type is shown in Fig. 15. This plant operates at a speed of ½-yard every minute, approximately. This type of plant requires one additional engineer and fireman on the hoist and two extra wheelers for wheeling cement from box car at the opposite end of train, where it must be placed to avoid the swinging crane, otherwise the crew is essentially the same as for the plain gravity conveyor.

It was observed that the wheelers' time in transit from cars to mixer were:

To mixer from adjacent car	15 seconds
To mixer from second car	30 seconds
To mixer from fourth car	40 seconds
To mixer from seventh car, at train end	1 minute 15 seconds

In connection with the two loaders in this cement car and the four cement wheelers the observed performance was:

Loader.	Time.	Elapsed.	Wheeler.
No. 1	11:25:30 to 11:27:00	1½ min.	No. 1
No. 2	27:00 to 28:30	1½ min.	No. 2
No. 1	29:30 to 31:15	1¾ min.	No. 3
No. 2	31:30 to 33:00	1½ min.	No. 4

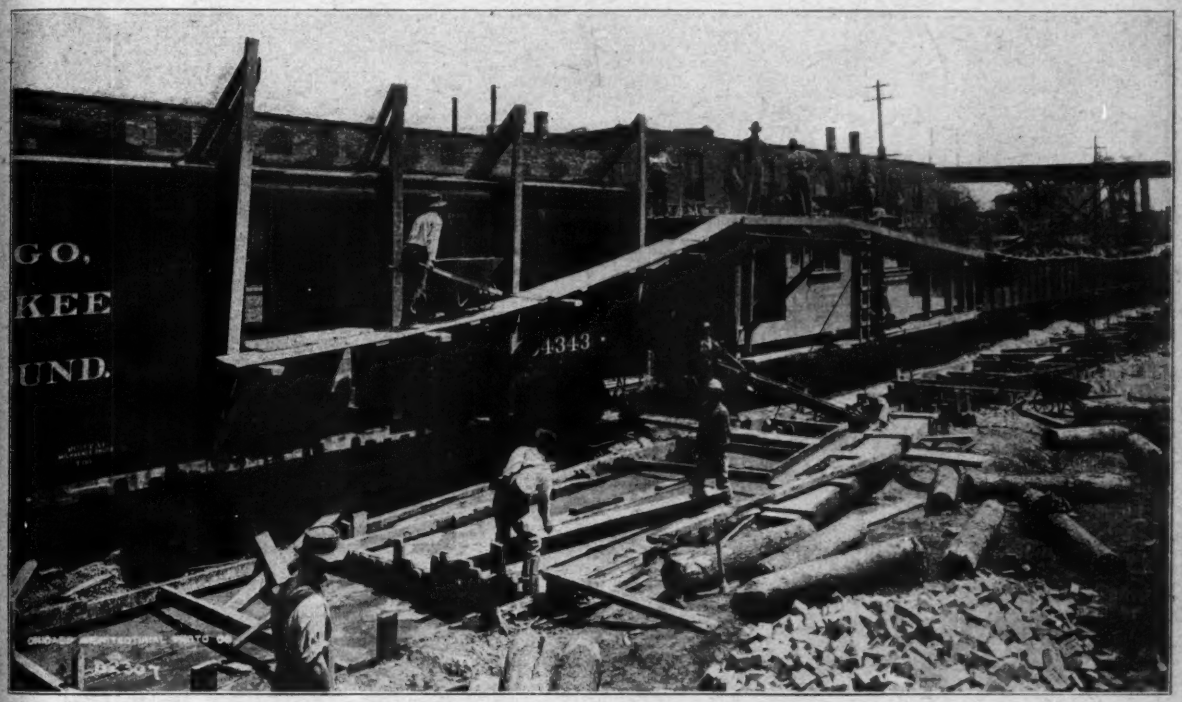


Fig. 14. Concrete Plant for Pouring Wall Footings, Bloomingdale Road Track Elevation, C., M. & St. P. Ry.

With the cement car at the opposite end of the train from the mixer a wheeler's round trip time was not less than four minutes on a seven-car train, considering practically no wait at the mixer hopper. The preferable location of the cement car immediately adjoining the mixer would take out 2 minutes from a wheeler's time with each load, as compared with the opposite extreme, so that a round trip would be made in 2 minutes and the wheeling be done by two men; a possible saving of $4.00 per day by this arrangement. With this outfit it was possible to pour two 25-ft. sections of wall, containing about 150 yards of concrete. By placing the cement car next to the mixer the unit cost would be reduced about 2½ cents per yard, based on the daily output given above.

The self-contained mixing and hoisting and distributing plant, shown in Fig. 16, was built especially for this work, with a tower so constructed that it can be folded back over the car for transportation when not operating or when necessary to clear obstructions over track. This plant is mounted on a flat car, and is operated by a 20 H. P. double-cylinder horizontal engine, operating both the ½-yard chain Belt mixer and the hoisting bucket in the 45-ft. tower. Steam is supplied by a 25 H. P. horizontal boiler. The tower supports a swinging

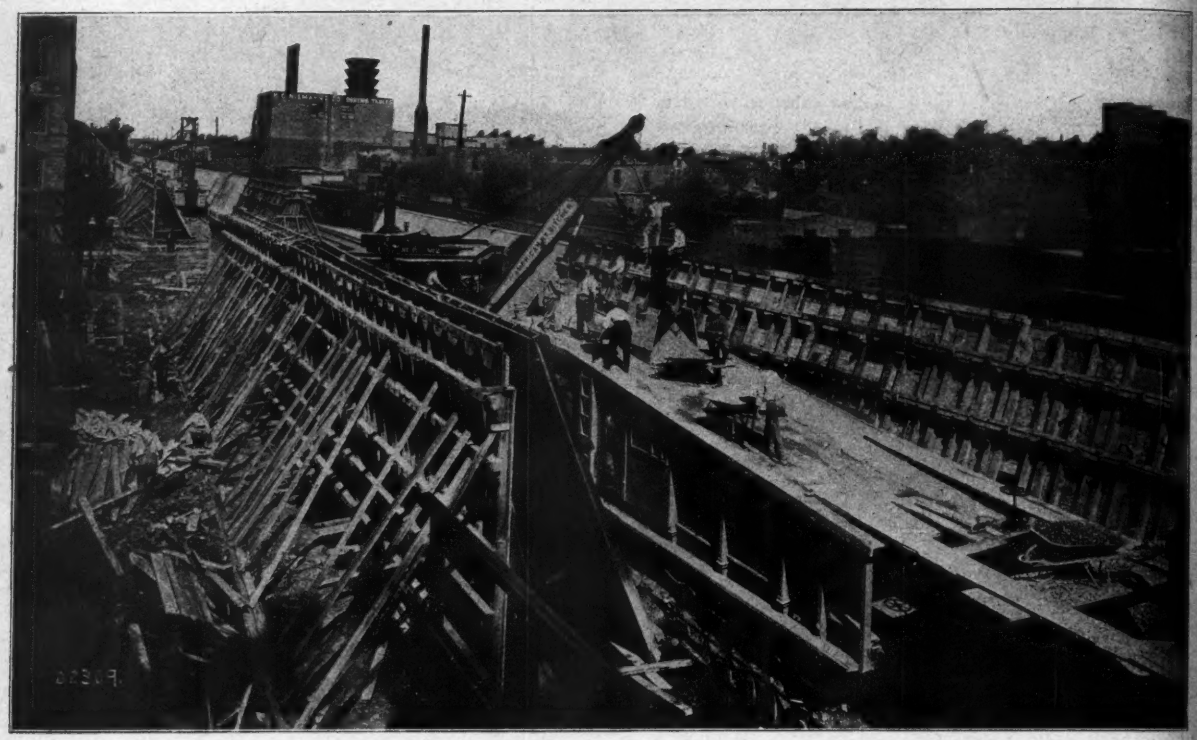


Fig. 15. Concrete Plant Employing Ditcher Derrick for Placing Concrete in Walls. Tower Distributing Plant in the Distance.

spout, which swings through 180 degrees for carrying the concrete from the receiving hopper at the top of tower to the wall forms. This machine was described in detail on page 423 of the September, 1913, issue of *Railway Engineering*.

Some idea of the capacity of this machine was obtained in May, of this year, when, with a good crew, 200 yards of concrete were placed in a 10-hour day. The crew necessary to operate this outfit efficiently is as follows:

22 sand and stone wheelers.
6 cement wheelers.
1 dumper at mixer.
1 man at chute.
1 man at hopper.
1 fireman.
1 engineer.
1 sub-foreman, and
1 cleaner and 2 facers on the forms.

In spite of the relatively large crew required, the unit cost of concrete is said to be from 7 to 10 cents per yard below that of the methods previously described.

Wall Forms.—The forms for retaining walls are built in units 25 ft. long with adjustable vertical members, to which the lagging is fastened. This adjustment allows the removal or addition of boards to increase or decrease the height of forms to suit the height of wall. The outer or vertical forms are braced by diagonal struts and the rear forms fastened to the face forms and kept at the required distance from them by bolts set in iron pipe sleeves, allowing the removal of bolts when removing forms. The individual sections of forms are handled by locomotive crane. At the time of concreting walls two slots, one near the top of wall and one near bottom, are left in one of the walls to receive pile stubs for the construction trestle which is erected after walls are complete.

Subway Construction.—As soon as possible after walls are complete the pile trestle from which the subways are constructed and the filling done, is erected. The bents of this trestle are composed of four piles, two driven down to firm bearing and the other two set in the slots left in one of the walls, the outer stub pile resting in a slot near the top of wall is necessarily very short. These bents are framed and capped in the usual manner and the temporary track laid. (See Fig. 17.)

From this trestle the subway abutments and piers are poured complete, and the deck slabs on the opposite half of bridge completed, and after filling between walls the track is shifted onto the completed portion and the other half of deck concreted.

The subway piers are now being cast in metal forms, built up in several sections. In the work done in 1913, however, wooden forms were used entirely.

The subway slabs are built in place on forms carried on two rows of heavy posts, resting on the pier footings, the stringers on which the joists carrying the lagging are laid, being very heavy, so as to leave almost the entire roadway open if necessary.

The concrete plant now being used almost entirely for concreting subways is the one using a drag line bucket for transfering the sand and gravel to the mixer. This machine, shown in Fig. 18, was jointly designed by W. B. Louer, of the Chain Belt Co., John W. Page, of the Page Engineering, and R. J. Middleton, engineer track elevation, and first put into service

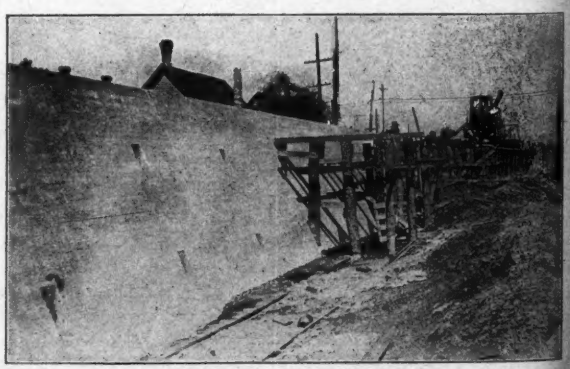


Fig. 17. Temporary Construction Trestle Showing Stub Piles Resting in Slots Left in Wall.

on the Bloomingdale Road work in the latter part of 1913. Mounted on flat cars at opposite ends of a construction train in which may be included as many as five gravel and sand cars are two 45-ft. steel towers hung on trunnions on which they may be folded down by hand winch and cable when shifting along the line. When the plant is in operation the towers are guyed by 1½-inch cables to the structural steel bracing erected on the cars and a cableway of proportionate size is run between the towers from the hoisting plant, where attachment is made to the drums of the hoisting engine. The power plant includes a 30-horse power boiler and engine with triple drums and special brakes to take care of the operation of the 1-yard grab bucket, which may be transferred to position over any of the gondolas containing material, and is loaded and hoisted to

In operation 60 yards of loose material per hour are handled with the 1-yard bucket, and 75 per cent of the material may be unloaded without assistance, while the mixer produces ½-yard of concrete in 60 seconds average, all with the aid of a crew of not more than 14, including:

1 cement loader.
2 wheelers.
2 chargers.
1 dumper,
1 fireman.
1 steam engineer.
1 gas engineer.
1 assistant foreman,
and 4 sand loaders to clean out the cars.

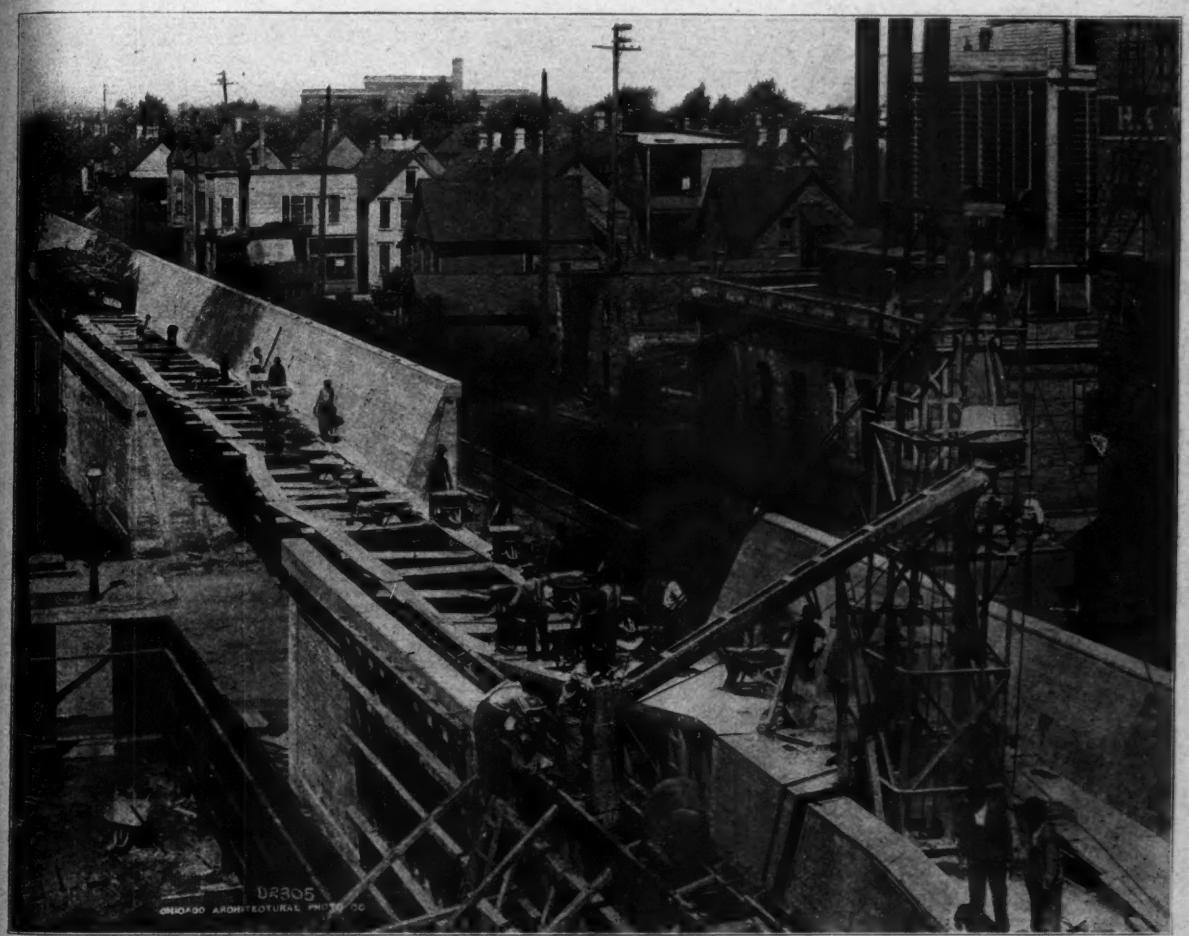


Fig. 16. Concrete Plant with Tower Distributor, C., M. & St. P. Ry.

the point where the aggregates may be dropped into storage bins on the mixing car at the end opposite from the hoist. Special connections in the power plant are run forward to a quadrant where the engineer can have full view of the grab bucket movements.

This year the outfit has been improved by making the mixing plant self-contained through the installation of the mixer, together with a belt conveyor, both operated by gas engines, on the same car with the storage bins. These latter have 30-yard storage capacity, which is sufficient for 1 hour's operation of the mixer. That operation may be continuous even when a small number of cars are attached, necessitating switching during the day, has been demonstrated when in 45 minutes' time the cableway has been taken down, empty cars switched out and full cars of material switched into the train.

The capacity of the plant is more than 200 yards per day, and the economy is said to be one-third better than with any of the other outfits. This plant is now pouring subway structures by chute and working full efficiency at the rate of 25 yards per hour, should place 250 yards per day.

Considering first cost and economy of operation, the drag line outfit compares most favorably with the tower machine and the locomotive crane apparatus. The economy made possible by using bulk cement is considerable on large jobs. As estimated by those in charge of the work the elimination of sacks means a reduction per barrel of:

2¼ cents in price.
2 cents previously chargeable to sack loss.
1 cent previously chargeable to bundling and freight handling,
or a total saving of 5¼ cents per barrel.

In some cases the locomotive crane and ordinary gravity chute outfits were used in subway construction, as shown in Fig. 19.

Filling and Drainage.—The filling is done from the temporary trestle by means of a Lidgerwood unloader operating on the dirt train. After the filling reaches the top of caps of bents the stringers and caps are removed and the track laid on the fill, and the remainder of filling done from it.

The fill is drained toward the street crossings to brick catch-basins, just back of abutments. These catch-basins have trapped connections to sewers.

Status of Work.—At the present time the 8 blocks of the work from Ashland Ave. west to Robey St. are completed with the exception of the steelwork for the Marshfield Ave. subway. The Robey St. subway is now under construction, and with the exception of some retaining walls between Robey St. and Hoyne Ave., very little except the preliminary and foundation work has been done west of the former street as far as Western Ave. West of this point all walls have been completed, and subways are being built between Artesian Ave. and Washtenaw Ave., the south half of subway deck being poured from temporary trestle. West of Washtenaw Ave. practically all subways are completed, including the monumental concrete structure, 250 ft. long, at Humboldt Blvd., built during the past winter, and the large subway at Kedzie Ave., and a good share of the filling is done. The Kimball and Ballou St. subways for the elevated yards are not yet completed.

The total amount of concrete which will be required for this work is about 135,000 cubic yards. During 1913 about 40,000 yards of concrete were poured in connection with retaining walls, foundations and walls themselves, while for the retaining walls which are expected to be finished by the fall of 1914, an additional 70,000 yards is required, this does not include concrete required for subways which must be completed according to ordinance by June, 1915.

Practically all work, with the possible exception of some subway work at Milwaukee Ave. and Winnebago St., should be completed this fall at the present rate of progress. A condition which tends to aid the rapidity of construction and avoid delay to traffic over the line and to construction trains is that a temporary track has been laid on Bloomingdale Road, outside of the right of way, over which freight traffic and construction trains, when going to different parts of the work, are operated. This track is not blocked by construction trains at any time, all work being handled from tracks within walls.

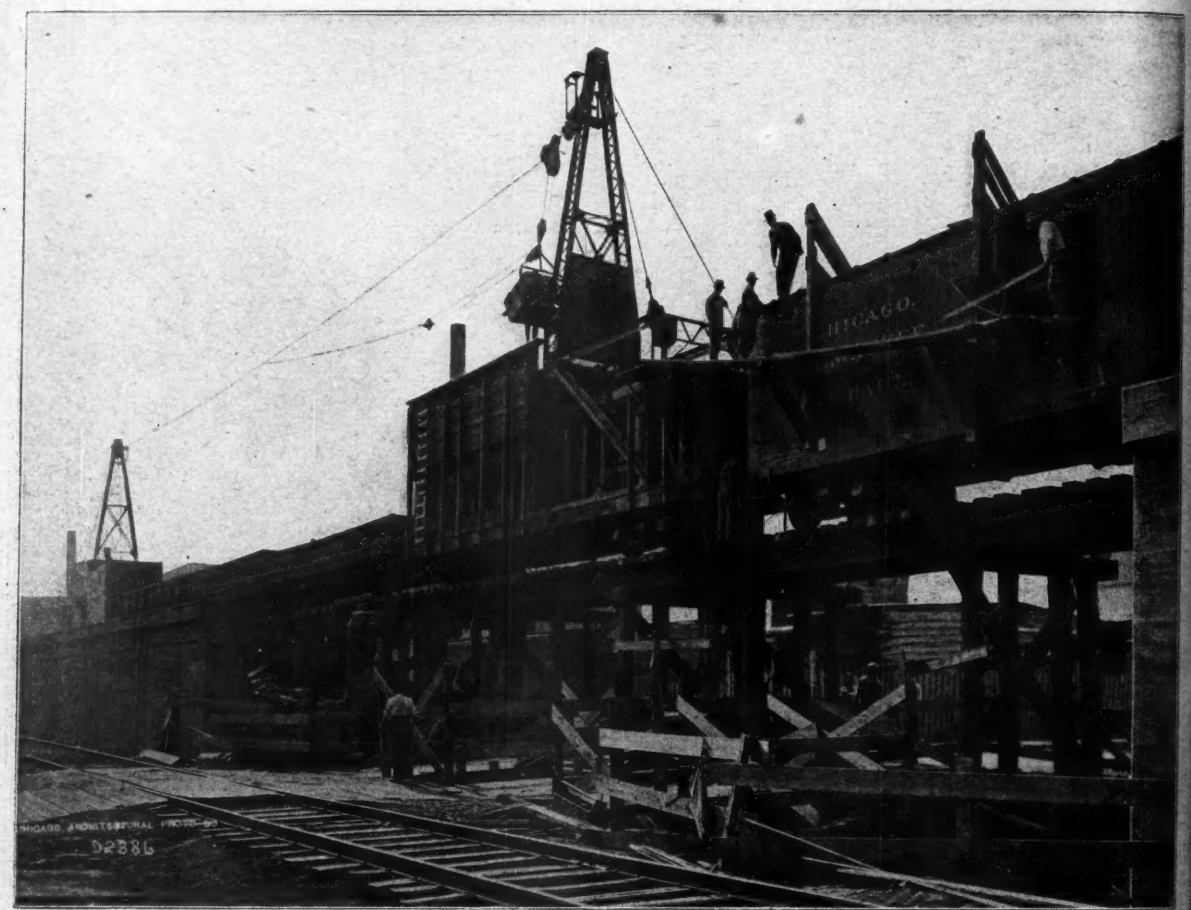


Fig. 18. Concrete Plant with Drag Line Bucket Equipment for Delivering Materials to Mixer.

Comment.

This piece of work is remarkable in many ways on account of the great number of street crossings and the size of some of them; and also because of the many different types of concrete used to carry out the work in the most efficient and economical manner. It is remarkable to note how smoothly the entire work is being carried out and how little delay or blocking of street or railroad traffic is occasioned. This is due to the excellence of the designs and the ability with which they are executed in the field by the engineers in charge.

Personnel.

The entire work of design and construction of all structures is in charge of the Engineering Department of the C., M. & St. P. Ry., Mr. C. F. Loweth, chief engineer; Mr. R. J. Middleton, engineer of track elevation; Mr. H. C. Lothholz, engineer of de-

sign; Mr. W. A. Kellner, assistant in charge of design; Mr. C. H. Buford and F. C. Loweth, assistant engineers in charge of construction. The writer is indebted to the above-mentioned for plans, photographs and data on structures used in this article, and to Mr. J. P. Beck, manager Publicity Bureau, Universal Portland Cement Co., and Mr. H. W. Robbins for photographs and data on concrete plants and the use of bulk cement.

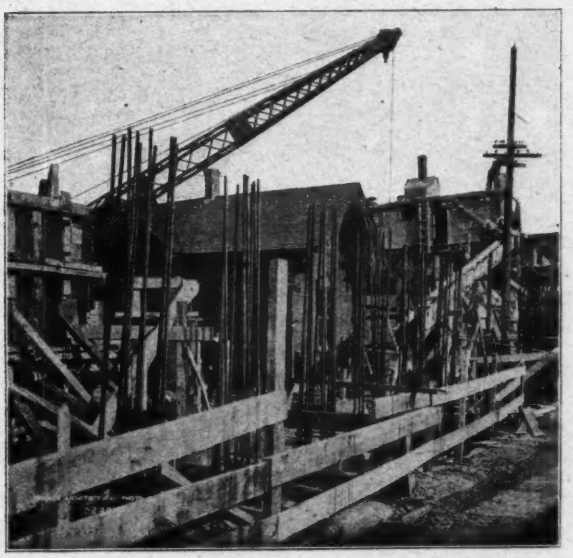


Fig. 19. Concreting Subway Pier. Concrete Delivered to Bucket in Locomotive Crane by Gravity, Then Raised and Placed in Forms.

LARGE SURGE TANK.

The largest tank of its kind has recently been built by the Kennicott Co., Chicago Heights, Ill., for the Salmon River power project at Altman, N. Y. The Erie Construction Co. was the contractor.

This surge tank acts as a governor on the pipe line, taking care of back pressure or surge when the load is suddenly taken off, or as a reservoir when the load is suddenly applied. It is connected to the lower end of the pipe line which is to convey the water from the dam to the power house. The pipe line is approximately ninety-five hundred feet long, ranging from eleven feet to twelve feet in diameter.

The surge tank constitutes an hydraulic regulating device for the power plant, being provided on account of the long pipe line. When the power plant is in operation and a sudden demand for more power occurs, necessitating an increased supply of water, the water is temporarily supplied to the turbines largely from the surge tank, while the velocity of the water in the long pipe is increasing to the required degree. On the other hand, when the power load is suddenly thrown off the plant, the surplus water will surge upward and spill over the top of the riser and will be caught and stored in the main bowl of the surge tank, while the velocity of the water in the pipe reduces gradually. The rise of pressure in the pipe line will at the same time be limited to that due to the water rising to the top of the riser.

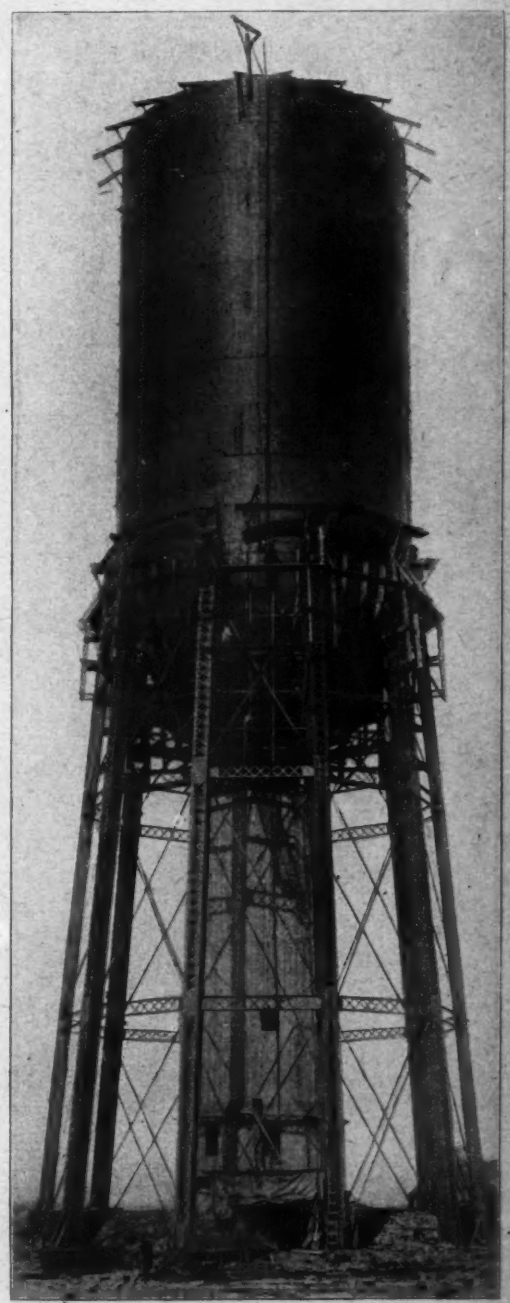
So-called "differential ports" are provided at the bottom of tank, the principal function of which is to retard the flow from the main tank to the turbines when the load on the plant is suddenly increased, so as to apply the full accelerating head to the pipe suddenly; another function being to check the rise in pressure more gradually than would be the case without such ports, when load is thrown off.

In actual operation the water level in the main tank fluctuates considerably and frequently, and the water level in the riser may frequently be considerably above or below that in the main tank for short intervals.

Operating Features.

The tank proper is cylindrical, with hemispherical bottom, and with general dimensions as tabulated above. The water flows to and from the surge tank through a section of twelve-foot steel pipe at about the ground level. This pipe is termed the "distributor," being the pipe which distributes the water to the several penstocks and turbines. A 12-foot by 12-foot by 12-foot steel tee, encased in concrete, constitutes the connection between this distributor and the riser to the surge tank.

The water enters and leaves the tank through a section of the riser, which is a vertical pipe, 12 feet in diameter, connecting the distributor tee with the bottom of the surge tank. An expansion joint is located in this section of the riser immediately below the bottom of the tank.



Surge Tank, Salmon River Power Project.

Inside the tank there is another section or extension of the vertical riser which is for the most part ten feet in diameter, flaring out on top to a diameter of fifteen feet, and also flaring out slightly at the bottom.

At the bottom of the portion of the riser inside the tank the construction is such that water flowing up toward the tank flows partly into the main tank through the differential ports and partly into the interior riser, and conversely, water flowing downward through the twelve-foot riser flows partly from the ten-foot riser and partly from the main tank through the differential ports.

A wooden housing surrounds the outside of the entire riser and tank, forming an air space as a protection against freezing, also for the circulation of heated air if desired. The housing is extended at the base of the riser, to constitute an entrance house and to provide space for heaters. Another extension or offset in the housing around the riser is provided at about the level of the expansion joint and has a floor or landing constructed of metal gratings. This constitutes a landing at the top of the stairs and serves also as space for additional heaters if required.

A wooden floor is provided at the top of the tank to constitute practically the cover of the housing. Suitable air traps are provided in this floor constituting openings for the inward or outward passage of the air during rapid changes of water levels in the tank, which changes are likely to be large and frequent. The air traps open when the required air change is of sufficient magnitude to make that necessary, but prevent circulation when unnecessary. The space between the air trap floor and the roof serves as an intermediate chamber for air entering or leaving the tank, and is open to the outside air all around the outer circumference of the air trap floor.

Enclosed stairways and ladders for convenient access to the expansion joint in the riser and to the floor at the top of the tank are provided. A ladder is also provided to extend down inside the tank from the floor at the top of the tank to the differential ports.

A substantial roof is provided for the top of the surge tank as well as for the entrance house at the base of the riser, and for the horizontal runway extending from the landing at the top of the stairway to the foot of the ladder leading to the top of the tank.

The surge tank is supported on a tower composed of ten structural steel lags or columns, which have bases bearing on foundations consisting of a massive annular ring of reinforced concrete.

Loads.

The tower supporting the tank is designed to carry the maximum possible dead load consisting of the entire weight of the materials of the structure, including the housing and the tank full of water, and in addition thereto, a roof load and live loads as well as a wind load computed on the basis of wind pressure amounting to twenty pounds per square foot over the maximum projection (in a vertical plane), of the entire structure, including the housing and roof. The wind forces are considered as acting in such a direction as to cause maximum stresses obtainable, and all features of the structure affected by this consideration are proportioned accordingly.

The hemispherical bottom of the tank supports the portion of the riser which extends up inside the tank proper. The top sixty feet of the interior riser are designed to withstand external hydrostatic pressure, due to a water level five feet above the top of the riser. From a point sixty feet below the top of the riser to the bottom of the same, the riser is designed to withstand safely, external hydrostatic pressure due to not less than sixty-five feet head of water. The portion of the riser which is below the hemispherical bottom of the tank is designed to withstand internal hydrostatic pressure due to a water level at the top of the tank.

The side and bottom plates of the tank proper are designed for internal hydrostatic pressure due to the tank being full of water.

The roof is designed for a live load of forty pounds per square foot, not including the wind load or the weight of the roof itself. The floor at the top of the tank is designed to carry safely a uniformly distributed load of one hundred pounds per square foot, including the space occupied by the air traps, and this load is taken into account as a part of the loads to be carried by the tank.

Unit Stresses.

In all compression members the unit working stress does not exceed fourteen thousand pounds per square inch. For compression members whose lengths exceed thirty times their least radius of gyration, the unit working stress is reduced in accordance with the Gordon formula for columns. No important compression member exceeds ninety radii of gyration in length. No other strut exceeds one hundred and twenty radii of gyration in length or such length that the extreme fiber stress due to bending from its own weight exceeds four thousand pounds per square inch.

The unit stress in the plates composing the sides and bottom of the tank do not exceed fourteen thousand pounds per square inch of net section, and plates less than one-half inch in thickness are not used. For other tension members in the structure, including bracing, the working stress does not exceed twelve thousand pounds per square inch of net section. The working stress of the members in shear does not exceed nine thousand pounds per square inch. Rivets in bearing are proportioned for unit stress not to exceed fifteen thousand pounds per square inch. Pins in bearing are proportioned for a unit stress not to exceed twenty thousand pounds per square inch. The safe bearing for the column bases on concrete foundations is taken at three hundred pounds per square inch.

Materials.

All metal in the structure, except rods which require welding or forging, is open-hearth steel, which is furnished in all respects in conformity with the American Manufacturers Standard Specifications.

The steel plates composing the hemispherical bottom of the tank is of the grade known as "Extra Soft Steel." The steel plates used in the construction of the tank cylinder is of the grade known as "Flange or Boiler Steel." The sway rods and rivets are of the grade known as "Rivet Steel."

The lacing bars and cover plates are of the grade known as "Railway Bridge Steel." The main members of the tower are of the grade known as "Medium Steel." All other steel parts are made of the grade of steel best adapted to the purpose in each case. Wrought iron used in making rods is first-class refined iron, known as "Best Bridge Iron."

The diameter of shell is 50′ 0″; height straight part of shell, 80′ 0″; depth of bowl bottom, 25′ 0″; total height of tank from bottom of bowl to top of shell, 105′ 0″; elevation of bottom above ground, 80′ 0″; height of roof, 20′ 0″; total height ground to top of roof, 205′ 0″; diameter of bottom riser, 12′ 0″; diameter of inside riser, 10′ 0″, with 15′ funnel at top; number of supporting columns, 10; number of panels in tower, 3. Size of sway bracing, 4″x1¼″ flat. Columns are made of 2-8″x8″x¾″ angles, 2-6″x6″x1″ angles, 2-24″x$\frac{15}{16}$″ plates, 1-34″x¾″ plate in the form of an open box with 3″x½″ cross lace bars. Base plates and columns, each 36″x1″x36″ with anchor bolts, 2-2½″ round to each column. Grillage under base plates of each column consists of 5-24″ 100 lb. I-beams and 12-15″ 42 lb. I-beams imbedded in concrete. Thickness of bowl bottom plates, ⅞″. Longitudinal seams in bowl bottom are triple riveted with butt strap joints; horizontal seams are quadruplicate lap. The first course of shell is 1″ plate, triple riveted, butt joint. Connection of bowl bottom for first course, 2-⅝″x36″ plates. Thinnest plate in tank, ½″ double riveted, butt strap. Top riser stiffened every four feet by 4″x4″x½″ angles to take care of difference in elevation of water inside the riser and in tank proper. The 12′ 0″ riser is connected to bowl bottom by means of special 12′ expansion joint.

The inside stiffening girder is made up as Howe trusses to take care of thrust of legs against tank.

General.

The bottom riser, bowl bottom, shell of tank and roof are encased by a two-ply wood casing, allowing an air space of 1' around the tank, the bottom air space is heated by means of electric coils and special heating system located at bottom of riser. The casing is attached to the steel shell by means of angle clips. The clips are bolted to the plank joists. Ladders are provided encircling bottom riser, walkway to tower and straight ladder outside of shell to top of tank; also down inside of tank to the center of bowl bottom. Sway pins $3\frac{7}{16}$" diameter are made of special steel.

The roof is made of steel girders covered with wood sheathing. The top flooring of the tank is provided with a special air-tight floor equipped with air traps so as to relieve the air pressure when water surges in and out of the tank. The shell is reinforced with two angles inside to each course so as to prevent collapsing when partial vacuum is created by sudden drop of water in tank. Connections between the tank and columns are taken care of by 256-⅞" rivets on each of the ten columns. The total number of rivets in complete structure is approximately 100,000. The weight of the complete structure is 810 tons.

Special hoisting equipment was made for this work. The mast of the derrick is 140' long; boom, 125' long. With this the columns, bottom and first course of tank were hoisted and placed in position with one setting of a derrick. The foundations for the supporting tank are made up as one solid reinforced concrete ring with grillage and piers built into ring.

The tank was manufactured under rigid inspection of material at the mill, shop and field.

POSITION OFFERED.

Position open for good track foreman, must be under 40 years of age, thoroughly competent and ambitious. Location: Western New York. Address L. F. W., care Railway List Co., 431 So. Dearborn St., Chicago.

PRESIDENT WILSON AND THE RAILWAY SITUATION.

On August 5th O. De G. Vanderbilt, Jr., president of the Weir Frog and Switch Company of Cincinnati, held a conference with President Wilson at the White House. A digest of their conversation, in the words of Mr. Vanderbilt, may be summed up as follows:

"The President realizes very keenly the extremely bad condition and lack of business of the manufacturers in this line of work, due to the very stringent economy which the railroads of the country have been forced to put into effect on account of the uncertainty as to future legislation affecting them, and that this has made it a very difficult matter to influence capital for badly needed new construction.

"He also realizes that the lack of buying, even of such necessary supplies for track work for the maintenance of already existing roadways, is due in a large measure to the reduced earnings of the railways, and he agrees thoroughly with the report of the Interstate Commerce Commission that the railroads are in need of relief and feels that this needed relief will be forthcoming as soon as ways and means can be decided upon which will protect the interests of the shipper as well as the railroads.

"The President feels that certain basic legislation is necessary before the business interests of the country can be put on a sound basis. As soon as this basic legislation is in force, it will be the attitude of the Administration to remove all uncertainty as to future legislation and the position of the Administration toward business.

"With conditions fundamentally sound and the doubt as to the attitude of the Administration removed, I thoroughly agree with President Wilson that this country should have prosperous times in spite of European conditions.

New Books

THE THEORY OF THE FLEXURE AND STRENGTH OF RECTANGULAR FLAT PLATES APPLIED TO REINFORCED CONCRETE FLOOR SLABS. By Henry T. Eddy.

Cloth, 6x9 ins., 104 pages, numerous text figures and illustrations. Published by Rogers & Co., Minneapolis, Price, $5.00.

This book in the opinion of the reviewer is misnamed, for it is in reality a "special plea" for the Turner Mushroom System of Flat Slab Construction. The preface written by Mr. C. A. P. Turner is more worthy of a place in a catalogue than a book of this character. It is to be regretted that such an admirable mathematical treatise as Mr. Eddy has written should be marred by commercialism.

The mathematical theory of the thin flat plate as applied to reinforced concrete slabs by Dr. Eddy is based upon the fundamental equations of extensional stress and strain in flat plates and slabs which among other things necessitates an assumption for the value of Poisson's ratio (the ratio of lateral contraction to longitudinal stretching). Ordinarily this is taken as 0.1 for concrete and about 0.3 for steel, but Dr. Eddy says "that, in the light of all known tests of slabs, the value that best satisfies all conditions is 0.5." In view of the scant evidence produced by Dr. Eddy this heretofore unheard-of value for Poisson's ratio cannot be accepted by the reviewer. It is recognized that the value used may be considerably in error without seriously affecting the results, but this should not be a reason for advocating the value in question, for errors in other assumptions may be cumulative and the results, although apparently correct, far from the truth. Other assumptions made in order to develop the theory are: that the actual reinforcement is regarded as distributed into a thin sheet of uniform thickness; that the concrete resists compressive bending stresses only and that the deformations in one direction are influenced by those at right angles. If these are accepted, the formulae are mathematically correct and easy of application. In line with the policy of the work, the formulae are applied only to the Mushroom type of construction in illustrating their use. Nothing is said regarding the design of end spans and one is therefore led to believe that such conditions are entirely neglected, although contrary to recognized laws of mechanics.

The results of the "so-called" comparative test of two slabs, a Norcross slab and a Mushroom slab, are misleading to say the least. It is not at all surprising, as the author would lead one to believe, that of two slabs of the same thickness, span and amount of reinforcement, one should show on test to be twenty times as strong as the other, as will be seen on examination of the data. In the first place the Mushroom slab 6 in. thick with a span of only 12 ft. each way was supported on 18 in. sq. columns with 42 in. sq. capitals, while ordinarily heads of such size are used for 18 and 20 ft. spans for Mushroom slabs. Contrast this with a slab of the same thickness with the rods placed in the most unsatisfactory manner conceivable carried on columns of about the same size as the other slab, without a flaring head or bracket of any sort. It does not take much technical education or sense to say which would be the stronger, for the Mushroom slab was designed and constructed to produce the best results in every particular, while the other was designed in just the opposite manner so as to make the Mushroom slab show up well in contract.

The flat slab has come to stay and the time is at hand when special tests and mathematical gymnastics will fail to cloud the real issue and cause doubt as to the real action taking place, and then the "mysterious part" of the design of flat slabs, pushed to the foreground at every chance in this book, will disappear.

CONCRETE DEPARTMENT

Turned Sections for Tension Tests of Reinforcing Bars

SOME engineers have been careful for some time past to specify that laboratory tests on steel for reinforcing bars should be made on the finished material and not on a machined test specimen, realizing that such tests did not reveal the true nature of the material. The matter, however, has never been given the necessary consideration and the majority of specifications for reinforcing steel allow the use of machined test specimens.

An interesting paper by E. P. Withrow and L. C. Niedner, presented at the 17th annual meeting of the Am. Soc. for Test. Mat., held at Atlantic City, June 30 to July 3, throws much light on the subject. The experience of the authors was that in any one type of bar the increase in yield point and ultimate strength caused by the removal of material in machined specimens exists as a variable quantity, often reaching an amount many times greater than the percentage of material contained in the deformations; the same was true of constant-section deformed bars and even in plain bars.

By tests on specimens without enlarged ends and on bars embedded in concrete at each end it was found that the same increase still existed and the difference therefore cannot be attributed to the enlarged ends. The indications are that the increase is caused by the chemical and structural non-uniformity of the bars, the latter probably offering the principal reason for the increase of strength of most plain and deformed bars when machined to a smaller diameter, and that this increase is irregular in bars having the same kind of deformations. The differences in strength probably due to non-uniformity of steel may, even in a constant-section bar, be greater than the reduction of section due to the removal of inactive deformations.

The authors state that, "since the removal of the exterior steel tends to give a higher reported value for bars than they would develop in service, it is not good practice to allow the machining of tests specimens of reinforcing bars."

In this matter we agree with the authors and hope to see the time when this "relic" of bygone days will be omitted from specifications. To make tests on reinforcing bars by using machined specimens is just about as unfair as it would be to test only the portion of cement which passed a 200-mesh sieve and record the results as the strength of the cement as received from the mill. The tendency of the times is toward the making of tests on concrete and concrete materials in such a way as to give results more nearly consistent with what can be expected in practice, and there is no just reason why steel for reinforcing bars should be favored as far as tests are concerned.

This is the time of the year that the utmost care should be taken to see that all fresh concrete is protected from the direct rays of the hot summer sun. Premature "drying-out" of fresh concrete weakens it and it should therefore be protected by boards, tarpaulins, or building paper until final set. After that exposed concrete should be covered with sand or shavings kept moist for several days. The result will be better concrete.

CURRENT PRICES — CONCRETE MATERIALS

Portland Cement—The cement market has advanced about 5c per barrel in the middle west since last month, except in certain localities, and the demand is good and shipments are at a heavier rate than ever before at this time of the year, and the outlook is quite encouraging. Prices given of f. o. b. cars at points named, including cloth sacks, for which, in general, 40c per barrel (4 sacks) is refunded on return in good condition. Prices per barrel (including 4 cloth sacks) are as follows: Boston, $1.72; New York, $1.58; Chicago, $1.57; Peoria, $1.59; Pittsburgh, $1.55; New Orleans, $1.64 on dock; Memphis, $1.82; Cleveland, $1.63; Detroit, $1.59 to $1.64; Indianapolis, $1.65; Columbus, $1.67; Toledo, $1.59; Ft. Wayne, $1.54; St. Louis, $1.55; Milwaukee, $1.64; Minneapolis and St. Paul, $1.75 to $1.80; Montreal, $1.75 to $1.80; Toronto, $1.95; Winnipeg, $2.40 to $2.50; Kansas City, $1.63; Davenport, $1.60; Omaha, $1.68; Portland, Ore., $2.10; Spokane, $1.80; Seattle, $2.30; Tacoma, $2.30; Duluth, $1.78.

Crushed Stone—1½ in. stone, prices per cubic yard, f. o. b. cars in carload lots, unless otherwise specified. Boston, 80c per ton at the quarry; New York, 90c to $1.00, in full cargo lots at the docks; Chicago, $1.05; Toronto, 75c per ton at quarries; Spokane, $1.25; Seattle, $1.25; Portland, Ore., $1.00.

Gravel—Prices given are per cubic yard f. o. b. cars in carload lots unless otherwise noted. Boston, 75c; New York, 90c to $1.00, in full cargo lots at docks; Chicago, $1.05; Portland, Ore., $1.00; Spokane, $1.25; Seattle, 75c; Winnipeg, $1.85; Tacoma, 75c.

Sand—Prices are per cubic yard, f. o. b. cars in carload lots unless otherwise indicated. New York, 50c, full cargo lots at docks; Chicago, $1.05; Toronto, $1.15; Portland, Ore., $1.00; Spokane, $1.00; Seattle, 75c; Winnipeg, $1.75; Tacoma, 75c.

Reinforcing Bars—The demand and the prices in general are about the same with a slight increase in demand in certain localities. Pittsburgh base quotations on mill shipments f. o. b. cars, are from $1.15 per cwt., with the prevailing extras on bars under ¾ inch or base. The following are quotations on base bars per 100 lbs., for mill shipments from other points, f. o. b. cars: New York, $1.31; Philadelphia, $1.30; Chicago, $1.33; Portland, Ore., $2.15; Spokane, $2.20; Seattle, $2.15; Tacoma, $1.95.

Shipments from stock are being made at the following prices per cwt. f. o. b. cars: Pittsburgh, $1.65; New York, $1.85; Cleveland, $1.80; Cincinnati, $1.80; Chicago, $1.85; Montreal, $2.20; Toronto, $2.15; Winnipeg, $2.50; Portland, Ore., $2.40; Spokane, $2.50; Tacoma, $2.20; Seattle, $2.15; San Francisco, $1.85.

Metal Clips for Supporting Bars—$5.50 to $6.50 per 1,000, depending on size.

For the majority of the prices given we are indebted to the Universal Portland Cement Co., Sandusky Portland Cement Co., Concrete Steel Co., American Sand & Gravel Co., Chicago, and F. T. Crowe & Co., Seattle, Portland, Spokane and Tacoma.

Reinforcing bars for mill shipments are in general sold on a Pittsburgh basis; this is, at the Pittsburgh quotations plus the freight to the point in question, and with the following list of freight rates on finished material and the Pittsburgh quotation given, the price of bars at any of the points listed can be readily computed.

From Pittsburgh, carloads, per 100 pounds to:

Albany	16 cents	Columbus	12 cents
New York	16 cents	Cincinnati	15 cents
Philadelphia	15 cents	Louisville	18 cents
Baltimore	14½ cents	Chicago	18 cents
Boston	18 cents	Richmond	20 cents
Buffalo	11 cents	Denver	84½ cents
Norfolk	20 cents	St. Louis	22½ cents
Cleveland	10 cents	New Orleans	30 cents
Minneapolis	32 cents	Indianapolis	17 cents
Kansas City	42½ cents	Omaha	42½ cents
Birmingham	45 cents		

Central of Georgia Railway Co.

Detailed Description of Standard Concrete Structures Now in Use.

By Albert M. Wolf, C. E.

The Central of Georgia Railway Company uses plain concrete in the construction of piers, abutments and arch culverts, and reinforced concrete for box culverts and abutments. The general plans of culverts both plain and reinforced with tables showing the detail dimensions and quantities of materials for a considerable number of different spans are especially valuable, due to their completeness.

Plain Concrete Pier.

Plain concrete piers are designed for Cooper's E-50 live load with an allowable bearing under truss bearings of 250 lbs. per sq. in. For the body of the pier concrete of a 1:2½:5 mixture is used while for the bridge seat 1:2:4 concrete is used. The standard top width under coping, which projects 6 in. on either side, is 5 ft. for piers on straight track; on curves the width is varied to suit the conditions.

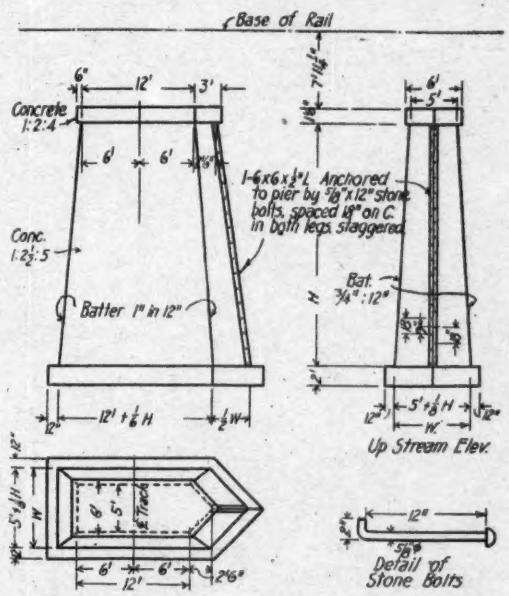

Base of Rail
Concrete 1:2:4
Conc. 1:2½:5
Batter 1" in 12"
1-6x6x½" L. Anchored to pier by ⅞"x12" stone bolts, spaced 18" on C. in both legs staggered
Bat. ¾":12"
Up Stream Elev.
Detail of Stone Bolts

Fig. 1. Details of Plain Concrete Piers.

As shown in Figure 1, the upstream end of pier has a 45 degree cutwater protected with a 6 in. angle nosing, while the downstream end is cut off square with a batter of 1 inch in 12, same as the upstream end. The sides have a uniform batter of ¾ in. in 12 in. from bottom of coping to footing, which is 2 ft. thick and projects 1 ft. beyond the neatwork.

Plain Concrete Abutment.

The plain concrete abutments shown in Figure 2 are typical of such structures for pile and solid foundations. The live loadings and concrete mixtures used are the same as for piers, while the earth pressure behind the wall was computed in accordance with the recommendations given in the February, 1909, Bulletin of the American Railway Engineering Association.

The diagrams (Figure 3) submitted by the A. R. E. A. committee are given herewith: (a) Method of graphical and analytical calculation of earth pressure for fill with level top; (b) for wall with surcharged fill at 1½ to 1, and (c) for wall

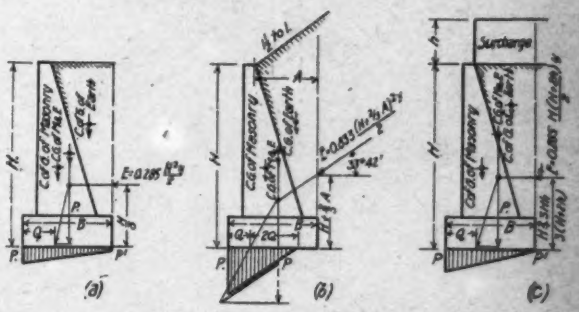


Fig. 3. Diagrams for Earth Pressures.

with a surcharge such as a superimposed lif live or dead load. This latter was used in computing the pressure on the main portions of abutments. The following rules were adhered to in design: In all cases the pressure on the foundation by this method will be determined by the following formula: When Q is equal to or greater than ⅓B, the pressure at the toe will be: $(4B-6Q)\ P/B^2$, and the pressure at the heel will be $(6Q-2B)\ \frac{P}{B^2}$. When Q is less than ⅓B, the pressure at the toe will be $\frac{2}{3}\frac{P}{Q}$. In these equations P is the vertical component of the resultant pressure on the base; B, the full width of the base in feet; Q, the distance from the toe to where the force

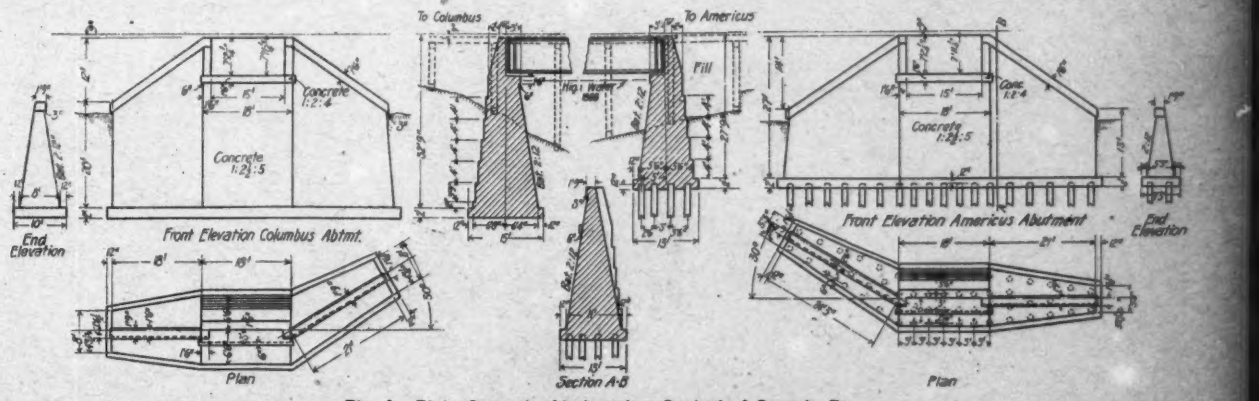


Fig. 2. Plain Concrete Abutments.—Central of Georgia Ry.

P cuts the base. The constants given apply only to earth that will stand on a 1½ to 1 slope, and it must be borne in mind that the pressure on the foundation should never exceed the safe bearing pressure on the material considered. The material back of the wall should be properly drained, otherwise the wall will be subjected to hydrostatic pressure, which greatly increases the lateral pressure. The wall should be secure against sliding, as well as capable of resisting the overturning moment. The frictional resistance on the base, combined with the abutting resistance of the earth in front of the wall, must be greater than the horizontal thrust of the earth back of the wall in order to prevent sliding of the wall on its foundation.

The faces of abutments are given a batter of 2 inches in 12, and the backs are stepped up in 4-ft. steps with a 6-in. offset up to the bridge seat. Above this the backwall is given a front batter of 2 inches in 12. The footing courses are made 2 ft. thick, with a width of about 0.45 of the total height and project 12 in. beyond the neatwork. Where piles are used they are capped with at least 12 in. of concrete and with a minimum spacing of 3 ft. one way and 2 ft. 6 in. the other.

The bridge seats have an 18 in. coping projecting 6 in. beyond the neatwork. The allowable bearing on bridge seats 250 lbs. per sq. in.; no impact being considered. The wing walls at upstream side of abutments are given a 30 degree flare, while the downstream wings are made straight where the conditions allow. Wings have a face and back batter of 2 inches in 1 ft. and a coping 1 ft. 9 in. wide projecting 3 in. beyond the neatwork.

Reinforced Concrete Abutment.

The reinforced concrete counterfort abutment shown in detail in Figure 4, has a total height of 29 ft. 9 in. from base to top of back wall, with a face wall 1 ft. 3 in. thick at the top and 2 ft. 7½ in. thick at the base, the back being vertical and the face having a batter of ¾ in. per foot. The counterforts 2 ft. wide are spaced 9 ft. 3 in. centers behind main portion of abutment and at a closer spacing for wing walls.

The abutment was designed to withstand earth pressure at the back with a superimposed load on the fill, in accordance with diagram "C," Figure 3, which is recommended by the A. R. E. A. In addition to this a live load on the bridge seat due to Cooper's E-55 loading without impact was taken into consideration. The allowable bearing on bridge seat under bearings was 250 lbs. per sq. in. All concrete used was of a 1:3:5 mixture. Deformed square bars were used for reinforcing with an allowable tension of 15,000 lbs. per sq. in., all bars being lapped 30 diameters at splices. The allowable stresses in the concrete were: 600 lbs. per sq. in. in compression and 40 lbs. per sq. in. for concrete in shear without shear reinforcement.

The footing course of the main portion of abutment is 3 ft. thick above piles which are covered to a depth of 6 in. Piles were driven only under the front portion of footing and directly under counterforts, as shown in the plan. The footing courses for wings are decreased by steps at counterforts to a thickness of 1 ft. 6 in. for the end section. The footings are reinforced with transverse bars, ¾ in., 1 ft. centers, alternate bars extending only about ½ the distance from toe to heel. The transverse bars below these are at a varying spacing of from 18 inches near back of wall to 6 in. centers near heel. The footing is 17 ft. wide or about 0.55 of the total height to base of rail, with about a 3 ft. projection at the front.

The face wall is reinforced as a slab between counterforts, with ¾ in. sq. bars 18 in. centers horizontal from top to bottom and ¾ in. bars 2 ft. centers vertical, 3½ in. clear from face.

The main buttresses or counterforts are reinforced at the back with eight 1¼ in. bars anchored in the footing course.

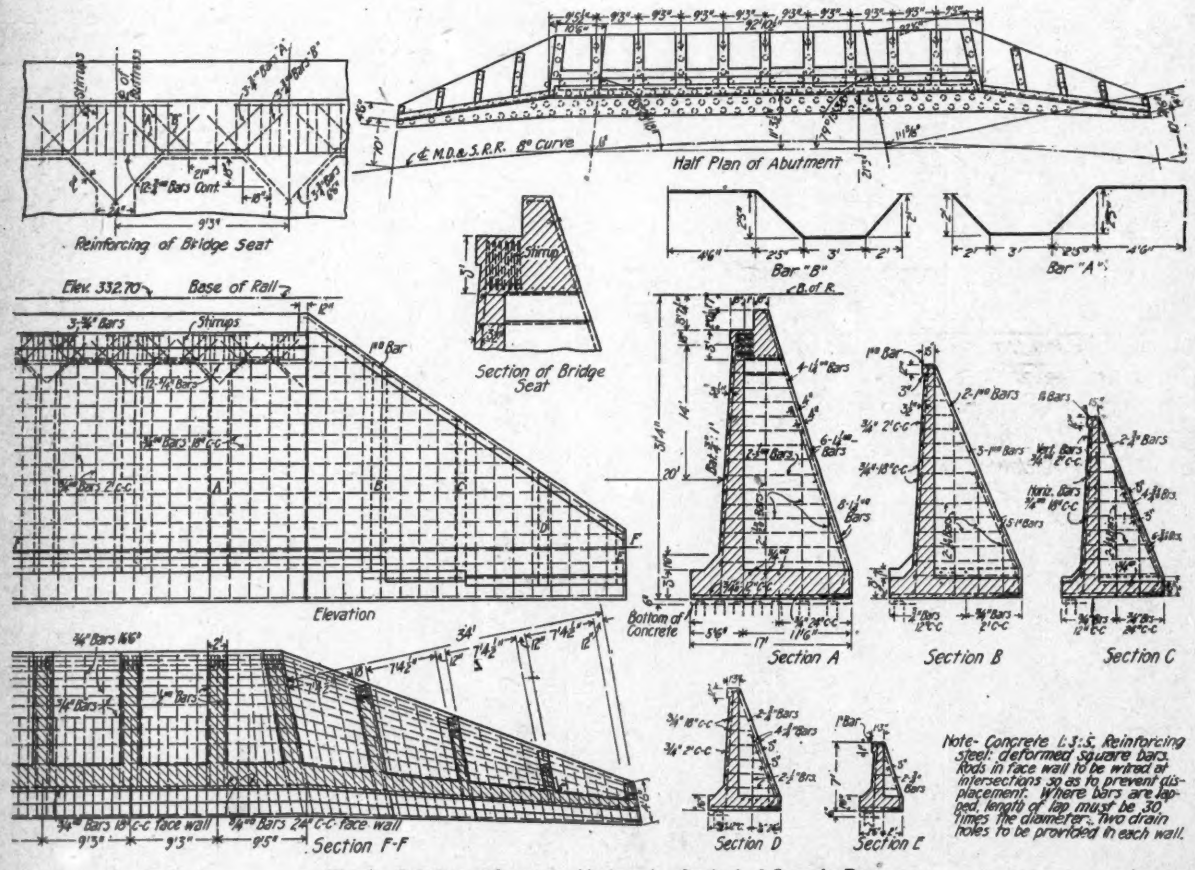

Reinforcing of Bridge Seat
Half Plan of Abutment
Section of Bridge Seat
Bar "B"
Bar "A"
Elevation
Section A
Section B
Section C
Section D
Section E
Section F-F
Note- Concrete 1:3:5. Reinforcing Steel: deformed square bars. Rods in face wall to be wired at intersections so as to prevent displacement. Where bars are lapped, length of lap must be 30 times the diameter. Two drain holes to be provided in each wall.

Fig. 4. Reinforced Concrete Abutment.—Central of Georgia Ry.

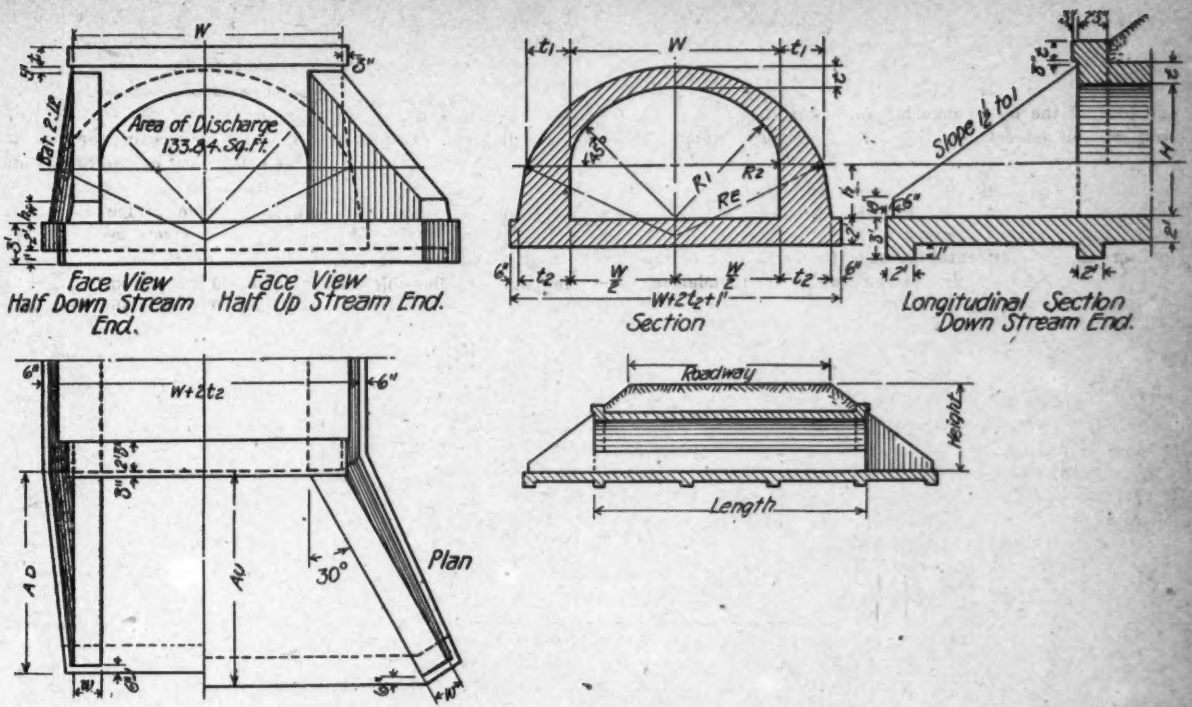


Fig. 5. General Plan, Elliptical Arch Culverts.—Central of Georgia Ry.

Only four of these bars extend to top of abutment, the rest being stopped off as shown, where not needed for tensile stresses. Besides these bars there are a few ½ in. bars vertical near faces of buttress. The face wall is tied to the counterfort by means of ½ in. sq. bars placed in pairs 18 in. centers horizontal and hooked over the horizontal bars in face wall. The wing-wall counterforts are similarly reinforced as shown in Figure 4.

At the top of the main counterforts is a heavily reinforced bridge seat 3 ft. thick and 2 ft. 6 in. wide, with a sloping back wall extending 2 ft. above the bridge seat level. The reinforcement of this seat consists of ¾ in. bars, six bent and twelve straight, so arranged (as shown in plan) as to provide partial continuity of the beam over the counterforts. Shear reinforcement in the shape of ¼ in. sq. multi-prong stirrups is provided. The bridge seat is connected to buttresses with 18 in. fillets reinforced with three ¾ in. bars at 45 degrees.

Elliptical Arch Culverts of Plain Concrete.

As early as 1904 the Central of Georgia had adopted arch culverts of plain concrete as standard, with dimensions as given in the accompanying table and general plans. These culverts, although originally designed for much lighter loadings than are now used, have given good service under the heavier loadings, and no occasion has been found for changing the details. The formulae used in the design of these culverts are not available.

By referring to the general plan it will be seen that the arches are really three-centered instead of elliptical, and that the sidewalls and wings have a back batter of 2 inches in 12.

TABLE of DIMENSIONS and QUANTITIES for PLAIN CONCRETE ELLIPTICAL ARCH CULVERTS. C of G. Ry. Co

Bottom Width (W)	6 Ft.	8 Ft.	10 Ft.	12 Ft.	14 Ft.	16 Ft.	18 Ft.	20 Ft.	25 Ft.	30 Ft.
Clear Height (H)	3'7½	4'9⅞"	6'0½"	7'2⅞"	8'5⅜"	9'7⅞"	10'10⅜"	12'1"	15'1"	18'1¼"
Area - Discharge	18.2 ☐	33.4 ☐	55.3 ☐	75.25 ☐	102.4 ☐	133.8 ☐	169.5 ☐	209.3 ☐	326.5 ☐	470 ☐
Crown Thickness (t)	1'0"	1'1"	1'2½"	1'3½"	1'4½"	1'6"	1'7"	1'8"	1'10½"	2'1"
Thickness Sidewalls at Springing (t1)	1'8"	2'0"	2'4"	2'8"	3'0"	3'4"	3'8"	4'0"	4'10"	5'8"
Thickness Sidewalls at Base (t2)	1'11"	2'4"	2'9"	3'2"	3'7"	4'0"	4'5"	4'10"	5'10½"	6'11"
Height of Side Wall (h)	1'6"	2'0"	2'6"	3'0"	3'6"	4'0"	4'6"	5'0"	6'3"	7'6"
No. of Ribs on Base	6	6	6	6	6	6	6	6	8	8
Main Radius (R)	3'7⅛"	4'9⅞"	6'0½"	7'2⅞"	8'5⅜"	9'7⅞"	10'10⅜"	12'1"	15'1"	18'1¼"
Secondary Radius (R1)	1'6"	2'0"	2'6"	3'0"	3'6"	4'0"	4'6"	5'0"	6'3"	7'6"
Extradosal Radius (RE)	5'0½"	6'6⅝"	7'11¼"	9'6⅝"	11'0⅝"	12'6⅝"	14'1⅝"	15'7"	19'4½"	23'2⅞"
Top Width of Wings (w)	1'2⅝"	1'4½"	1'6⅞"	1'9¼"	1'11⅝"	2'2"	2'4½"	2'3⅛"	3'1"	3'6⅛"
Height of Wings at end (hw)	1'0"	1'1"	1'2½"	1'3½"	1'4½"	1'6"	1'7"	1'8"	1'10½"	2'1"
Length Downstream Apron (AD)	5'9"	7'5⅜"	9'3¾"	11'1¼"	12'11"	14'8¾"	16'6¾"	18'4½"	22'10½"	27'5⅜"
Length Upstream Apron (AU)	6'3"	8'2⅛"	10'1¼"	12'0"	13'10¾"	15'9¾"	17'9¼"	19'6"	24'5"	29'2⅝"
Cu. Yds. Concrete in Aprons & Wings	27.5	42.8	62.7	86.7	116.1	151.1	190.2	277.7	382.5	567.9
Cu. Yds. Conc. per Linear Ft. of Barrel	1.42	1.94	2.56	3.2	3.9	4.66	5.46	6.36	8.80	11.6
Cu. Yds. Conc. per Rib of Base	0.8	1.0	1.22	1.43	1.6	1.8	2.1	2.3	2.8	3.3

Fig. 6. Dimensions and Quantities, Arch Culverts.

The bottoms are uniformly 2 ft. thick, with stiffening ribs at ends of aprons and culvert barrels and two intermediate uniformly 2 ft. wide and projecting 1 ft. below the bottom of the slab. An intermediate rib is used in aprons of larger culverts. The parapets are uniformly 2 ft. 6 in. wide, projecting 3 in. beyond face of arch. The depth of these parapets is the same as the thickness of the arch rings at crown, as will be seen from the table, Figure 6. The downstream wing walls are continued out parallel with the center line of culvert, while the up-stream wing walls are flared at 30 degrees with the sidewalls. The tops of all wings are sloped at 1½ to 1. The main dimensions of these culverts are given in the general plan (Fig. 5) and the table (Fig. 6).

Reinforced Concrete Box Culverts.

The later designs for culverts are exemplified by the general plan (Fig. 7) and the table (Fig. 8), which gives the general dimensions, thickness of slabs and walls, and the reinforcing for the same.

These culverts are designed for Cooper's E-50 loading, with 50 per cent impact allowance, with the following unit stresses in materials:

Steel in tension, 12,500 lbs. per sq. in.

Concrete in compression, 500 lbs. per sq. in.

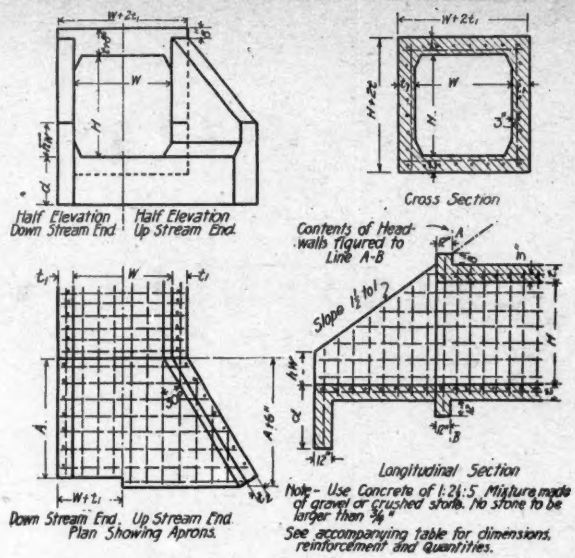
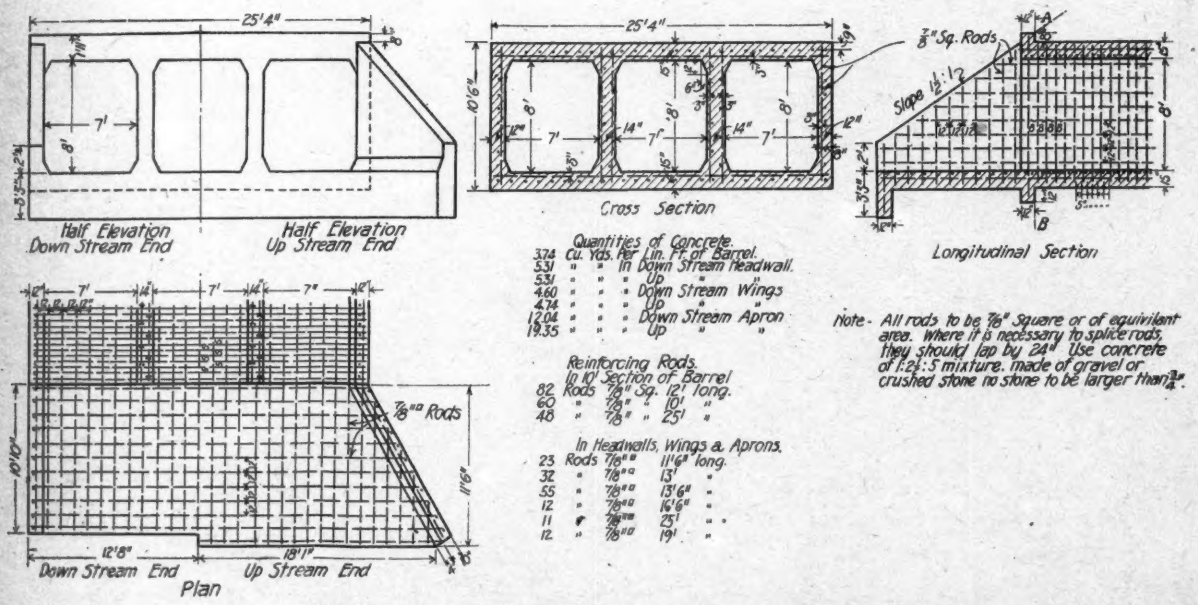

Half Elevation Down Stream End
Half Elevation Up Stream End
Cross Section
Down Stream End
Up Stream End
Plan Showing Aprons.
Contents of Head-walls figured to Line A-B
Slope 1½ to 1
Longitudinal Section
Note - Use Concrete of 1:2½:5 Mixture made of gravel or crushed stone. No stone to be larger than 2½"
See accompanying table for dimensions, reinforcement and Quantities.

Fig. 7. General Plan, Reinforced Concrete Box Culverts.

TABLE of DIMENSIONS, REINFORCEMENT and QUANTITIES for REINFORCED CONCRETE BOX CULVERTS. C. of G. Ry. Co.

Inside Width (W)	3 Ft.	4 Ft.	4 Ft.	5 Ft.	6 Ft.	8 Ft.	7 Ft.
Inside Height (H)	4 Ft.	4 Ft.	5 Ft.	5 Ft.	6 Ft.	6 Ft.	8 Ft.
Thickness Top & Base (t)	10 In.	10 In.	10 In.	12 In.	12 In.	15 In.	15 In.
Thickness Sidewalls (t1)	10 In.	10 In.	10 In.	12 In.	12 In.	15 In.	12 In.
Thickness Flaring Wings (t2)	8¾ In.	8¾ In.	8¾ In.	10 In.	10 In.	13 In.	10 In.
Depth of End Baffle (d)	2' 10"	2' 10"	2' 10"	2' 10"	3' 10"	3' 10"	3' 10"
Length of Downstream Apron (A)	4' 3"	4' 3"	5' 9"	6' 0"	7' 6"	7' 10"	10' 10"
Transverse Bars in Slabs & Vert. Bars in Walls	¾" @ 8" cts.	¾" @ 8" cts.	¾" @ 8" cts.	⅞" @ 8" cts.	⅞" @ 8" cts.	⅞" @ 5" cts	⅞" @ 5" cts.
Longitudinal Bars in Slabs and Walls	¾" @ 12" cts.	¾" @ 12" cts.	¾" @ 12 cts.	⅞" @ 12" cts.	⅞" @ 12" cts.	⅞" @ 12" cts.	⅞" @ 12" cts.
Bars in Wings and Aprons Both Ways	¾" @ 12" cts.	¾" @ 12" cts.	¾" @ 12" cts.	⅞" @ 12" cts	⅞" @ 12" cts.	⅞" @ 12" cts.	⅞" @ 12" cts.
Cu. Yds. Concrete per linear ft of Barrel	0.55	0.61	0.68	0.91	1.06	1.26	1.46
Cu. Yds. Concrete in Wings, Aprons & Parapets	6.25	7.00	9.15	12.6	16.1	25.4	28.6

Fig. 8. Dimensions and Quantities—Box Culverts.


25'4"
Half Elevation Down Stream End
Half Elevation Up Stream End
Cross Section
Longitudinal Section
⅞" Sq. Rods
Slope 1½ to 1
Quantities of Concrete.
374 Cu. Yds. Per Lin. Ft. of Barrel.
5.31 " " " In Down Stream Headwall.
5.31 " " " Up " "
4.60 " " " Down Stream Wings
4.74 " " " Up " "
12.04 " " " Down Stream Apron
19.35 " " " Up " "
Reinforcing Rods.
In 10' Section of Barrel
82 Rods ⅞" Sq. 12' long.
60 " ⅞" " 10' "
48 " ⅞" " 25' "
In Headwalls, Wings & Aprons.
23 Rods ⅞" @ 11'6" long.
32 " ⅞" @ 13' "
55 " ⅞" @ 13'6" "
12 " ⅞" @ 16'6" "
11 " ⅞" @ 25' "
12 " ⅞" @ 19' "
Note - All rods to be ⅞" Square or of equivilant area. Where it is necessary to splice rods, they should lap by 24" Use concrete of 1:2½:5 mixture. made of gravel or crushed stone no stone to be larger than 2½"
⅞" Rods
Down Stream End
Up Stream End
Plan

Triple 7 Ft. x 8 Ft. Concrete Box Culvert.—Central of Georgia Ry.

Concrete in tension, 50 lbs. per sq. in.

Concrete in shear, 100 lbs. per sq. in.

Concrete of a 1:2½:5 mixture with ¾ in. gravel or crushed stone for the coarse aggregate is used for all reinforced culverts. Square twisted bars are used for reinforcement, and where splices are necessary the bars are lapped 18 inches for ¾ inch bars and 24 inches for ⅞ inch bars. All bars are kept at least 3 inches clear from the reinforced face. The various culverts are reinforced, as shown in the general plan with reinforcing of size and spacing indicated in the table (Fig. 8).

The top and bottom slabs are the same thickness throughout and are filleted to the sidewalls by 8x4 in. fillets up to 5 ft. spans, and 10x5 in. fillets for greater spans. The headwalls or parapets are 12 inches thick and the tops are uniformly 8 in. above the top of slab. At the ends of aprons are baffle walls 12 in. thick and of a varying depth, as shown in the table. At the ends of culvert barrel a 12x12 in. rib is placed below the bottom slab to stiffen the slab. The upstream wing walls are flared at 30 degrees with center line of culvert, while the downstream wings are prolongations of the sidewalls. The upstream wings and apron are made 6 in. longer than at the downstream end.

The table gives the quantities of concrete per linear foot of barrel and the total for wings, aprons and headwalls figured to the back of the parapet, line A-B in the general plan.

Triple Box Culvert.

The triple 7 ft. x. 8 ft. reinforced concrete box culvert shown in detail in Figure 9 is designed in the same manner as the standard single box sections just described. This type of culvert is used for low creek crossings where a fairly large waterway is required. The wing walls, aprons and headwalls require 51.4 cubic yards of concrete, while 3.75 cubic yards are required per linear foot of barrel.

Comment.

The writer is indebted to Mr. C. K. Lawrence, chief engineer, for plans and data used in this article.

CONCRETE BRIDGE FLOORS.

* Abstract from The Elimination of Grade Crossings on the N. Y., C. & St. L. R. R. in Cleveland, O., by A. J. Himes. Bulletin No. 160, A. R. E. A.

In the Cleveland work, it was required that the railroad bridge floors be relatively noiseless and waterproof. In former years every effort has been put forth to build shallow floors so as to minimize the change of grade. Such floors have always permitted the muddy water to seep through upon people passing below and have operated as drums in accentuating every sound from the passing trains. To overcome these defects the floors were made of I-beams and concrete slabs upon which tracks were laid and ballasted as upon the ground. Such a design requires a greater depth of floor which means a greater change of grade, and more steel to carry the added weight of concrete. The bridge is therefore more expensive; but in cities where the noise is troublesome, the ballasted floor is a great improvement. Trains passing over such floors are noticed but little more than when passing over solid ground.

A concrete floor slab can also be made reasonably water-tight. The writer's first experience with concrete was on the Missouri in 1887-88. Later it was used a little on the New York state canals, and still later in bridge construction on the Nickel Plate. During this period many experiments had been made and papers written in which it was sought to demonstrate that concrete can be made practically impervious to water and also that it cannot. Much concrete had been built that was very porous and there sprung up numerous business enterprises for the manufacture and sale of waterproofing material. Both observation and experience indicated that watertightness could be secured by either concrete alone or in combination with waterproofing. The requisite seemed to be that the material and workmanship should be the very best. If poor waterproofing were placed over poor concrete, the structure would leak. If the concrete were good, it would hold water, either with or without the waterproofing.

Especial efforts were made to avoid the entrance of water between the steel and concrete and at points of contraflexure and where cracks might develop from temperature changes. Bevel flashings of steel were riveted to the girder webs and malleable cast flashings were fitted around the stiffeners to cover and seal the edge of the concrete. This design was very successful. At points of contraflexure over curb supports and at Cedar avenue over the center columns, it was realized that cracks would develope and an attempt was made to forestall their appearance by the construction of joints. The joints were carefully provided with gutters and drainage pipes, and it was hoped that no trouble would be had with the water. The cracks were successfully forestalled, but the drainage was unsuccessful. The channels soon became clogged with cinders and the details of the steel work in the cross-girders did not leave room for a sufficient body of concrete, and in some instances the concrete proved imperfect. So, while the slabs proved generally tight, there has been some leakage at the points of contraflexure.

Much reliance had been placed on the use of direct labor and carefully selected foremen, but there came a great rush of work at a critical time and the floors suffered. In East Cleveland at a later date, it became necessary to build waterproof joints at the hinges of the arch bridges.

The concrete in the floor slabs cost about $12 per cu. yd. in place.

Now that the bridges are completed and have been two or more winters in service and the conclusions are as follows:

1. Concrete can be made watertight, under low-heads, for all practical purposes.

2. The mixing, placing and ingredients of concrete are subject to such a great number and variety of defects that only the keenest attention will secure an impervious structure.

3. Contraflexure temperature changes and settlements will produce cracks.

4. It is best to forestall cracks with predetermined joints.

5. Joints may be sealed against water if well designed.

On the underside of the bridge floors the concrete is protected from locomotive blasts by cast-iron plates, ½ in. thick and 36 in. wide. They weigh 71 lbs. per linear foot, and cost $5.23 per foot in place.

PAINT ON CONCRETE SURFACES.

A paper presented before the American Society for Testing Materials by H. A. Gardner of Washington, D. C., is of interest in that much new data is given regarding the painting of concrete. The test of two years' duration was made on a cement-stucco test fence in Washington. Before applying any of the paints a priming coat of 25 per cent zinc-sulphate solution was applied to the concrete to neutralize any free lime. This precaution, however, is said to be unnecessary if the surface is dry when painted and will not be exposed to the weather.

Thirty-five different paint mixtures were applied to as many different panels of the fence, three coats being used in every case. Good oil paints gave very satisfactory service, while water paints and varnish or other resinous paints do not. The oil paint is not attacked by dry cement and retains both texture and color. Equally satisfactory results were obtained with boiled linseed, mixtures of raw and boiled oil and mixtures including Chinese wood oil. These paint coatings were found excellent for concrete floors, being durable, wear-resisting and dust-preventive.

The American Society for Testing Materials has added to its specifications for reinforcing steel rolled from billets, an intermediate grade between the structural and hard grades. This new grade to have a yield-point of 40,000 lbs. and an ultimate tensile strength of from 70,000 to 85,000 lbs.

The Signal Department

SIMPLIFICATION OF THE SIEMENS & HALSKE CONTROL APPARATUS.*

The large goods yard at Magdeburg-Rothensee, which was intended to replace the old goods yard was completed and in work on the 8th of August, 1910.

The operation of the points and signals of the more important groups was concentrated in three cabins by means of electrical apparatus on the Siemens & Halske system. Nevertheless, in order to reduce simultaneously the first cost of installation and the consumption of electric current, some simplifications, which the nature of the traffic permitted, were introduced into the arrangement of electric connections and the construction of the portion of the central apparatus relating to the operation of the points at the head of the groups of sidings.

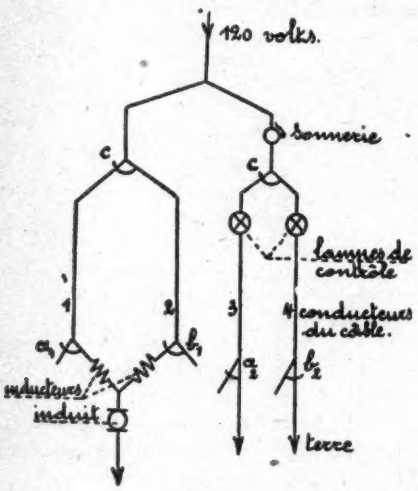


Fig. 7.

Explanation of French terms: Conducteurs du câble = Leads or Wires. — Inducteurs = Electro-magnets. — Indult = Armature. — Lampes de contrôle = Indicator lamps. — Sonnerie = Bell. — Terre = Earth.

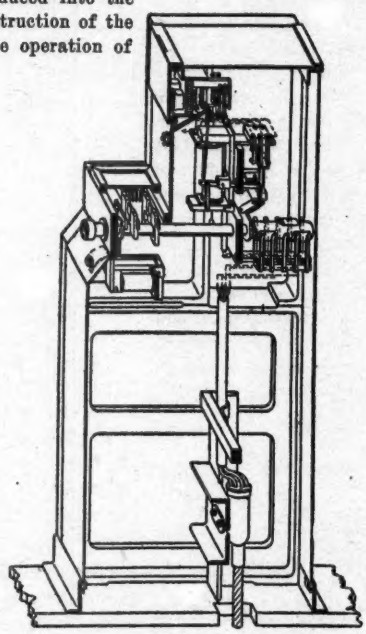


Fig 8 — Section of the central apparatus, old form of construction, with controlling current.

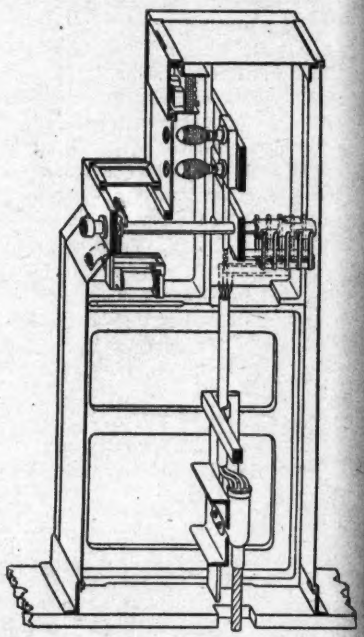


Fig 9 — Section of the central apparatus for groups of sidings, new and simplified model, without controlling current.

The particulars which follow are extracted from a very interesting article published in the *Zeitschrift des Vereines deutscher Ingenieure*, of February 17, 1912, by Mr. Niemann, traffic manager of the second Section of Essen on Ruhr, who prepared the scheme of simplification which was carried out.

The operating levers of the central apparatus are only spaced 60 millimetres (2⅜ inches) from center to center, instead of 75 millimetres (2¹⁵⁄₁₆ inches) which is the normal distance for central apparatus, a reduction which has enabled the length of the frames to be appreciably diminished.

To prevent a set of points from being operated while a vehicle is passing over them, it had hitherto been the practice to insulate the points electrically in such a manner as to form an electric circuit passing round an electro-magnet fitted in the central apparatus; the armature of that electro-magnet acts upon the operating lever in such manner as to lock it when a vehicle is on the points. This arrangement, which is somewhat costly and requires heavy maintenance of tracks which are subjected to such heavy traffic as are the heads of the groups shunting sidings, has been replaced in Magdeburg by a rail contact, arranged at the point of the tongue of the points in such manner as to close the electric circuit when it is loaded by a wheel. The armature of an electro-magnet inserted in this circuit locks the operating lever so long as the electric circuit is closed; an indicator disk, which appears behind an opening in the central apparatus arranged below the operating lever, enables a signalman to ascertain whether the points are covered by rolling stock. In order to increase the period of locking in such manner that the points are not freed until the last vehicle has left them, the armature is coupled to a retarder filled to a certain height with mercury and adjusted so as to slow the movement of the armature after it has been attracted and to maintain the interlocking for a sufficient length of time to ensure that it will continue until after the vehicle has cleared the points. This very simple arrangement is effective when it is a question of moving vehicles; it would also work equally well when the axle of a vehicle which had just come to rest happened to be over the rail contact; it may, therefore, suffice when it is a question of the shunting sidings, because these points are but seldom occupied by stationary stock.

Up to the present, notwithstanding the economy in working resulting from the diminution in the number of the signalmen, the main obstacle to the extension of electrical working for the points of shunting sidings in so simple and so rapid a manner, independently of the high cost of installation, as compared with mechanical operation (electrical working disposing with the interlocking bars and locking frame), had been the consumption of electric current caused by the use of the permanent controlling current which is a feature of the Siemens & Halske system.

The permanent current has for its object the controlling and indicating in the cabin the position of the points and prevents a signal being taken off except when the corresponding route is perfectly clear. Consequently, it prevents the operation of the route lever and of the signal lever when one of the points in question does not happen to be in the position which corresponds to that occupied by the lever in the cabin; if, after the signal has been set to "line clear" a set of points is operated, by being taken trailing for example, the controlling current ceases to flow and the signal returns automatically to the danger position.

But when it is a question of the points at the head of a group of shunting sidings, there is no signal for each route. All the points are taken facing; there is, therefore, no reason

*Bulletin of the International Railway Congress.

to fear their being taken trailing and the necessity for a permanent controlling current ceases to exist. It is, therefore possible to abolish the indicating apparatus, except when special points are in question, interlocked with the signal and used, for example, to divide a group of shunting sidings into two portions on each of which shunting operations can be proceeding independently.

The following advantages result from the suppression of the permanent controlling current:

1. The consumption of current is reduced to about one-fourth.
2. The accumulator battery working at 30 volts which was necessary for the supply of the controlling current is not required.
3. The arrangement of the central apparatus is simplified.

Figure 7 represents diagrammatically the electric connections for the operation of a set of points.

The electric switches C are operated by the lever actuating the points; the switches b_1 and b_2 are closed by the operating gear at the beginning of its travel, the switches a_1 and a_2 are opened at the end of the movement when it is required to return the points from the normal position to the thrown-over position. For movement in the opposite direction, the switches a_1 and a_2 are closed at the beginning of the movement of the point tongues of the switches b_1 and b_2 at the end of the movement. 1, 2, 3, and 4 are the cores of the cable connecting the points to the central apparatus.

The two lamps of the controlling and indicating apparatus are arranged in the central frame above the actuating lever and behind window openings fitted with transparent indicators carrying the sign — and the sign +.

It follows from this arrangement that under normal conditions no circuit is closed. In operating the lever to throw over points, the signalman closes a circuit at 120 volts by the wire 1, the switch a_1, one of the magnets, the armature and the earth on the one hand; and by the bell, one of the control lamps, the wire 3, the switch a_2 and the earth, on the other hand. These electric currents are interrupted by the switches a_1 and a_2 when the point tongues have traveled their full distance. During the whole time of the operation the bell continues to ring and the lamp lights up the indicator carrying the sign —.

When the points are operated in the opposite direction, the indicator showing the sign + is illuminated.

Figures 8 and 9 show clearly the simplification which results from this arrangement in the construction of the central apparatus.

The operation of a set of points requires four leads; if a spare lead is fitted and a lead is provided for the rail contact it will be seen that six wires will suffice for each set of points. These wires are all contained in a single armored cable; to reduce the cost of the cables it is usual to employ cables having thirty-seven wires, and supplying a group of six sets of points; the thirty-seventh wire serves as the common return wire.

From the calculations it appears that the first cost of each set of points varies from 910 to 935 marks (from £45 10s to £46 15s), including the cost of the battery, of accumulators and the transformers for charging the battery.

During the period of four years that this installation has been at work, its operation has given complete satisfaction; it has fulfilled all the conditions desired for the safety of working in this special case and has considerably simplified the work of the signalmen.

PENNSYLVANIA COMPLETES SIGNAL INSTALLATION.

With the completion on September 1 of an elaborate plan of improvements in its automatic block signal system, the Pennsylvania Railroad will have more four-track line operated under automatic signals than any railroad in the world. At a cost of $6,000,000, the Pennsylvania Railroad has in the past three years equipped 253 miles of its main lines with automatic signals.

On September 1 the main line of the Pennsylvania Railroad between Pittsburgh and New York and Philadelphia and Washington will be equipped with automatic block signals. The signal system on the Pennsylvania Railroad East of Pittsburgh and Erie represents an estimated investment of approximately $18,000,000. The difficulty in arriving at more than an approximate figure is due to the fact that many changes have been made in the signals from time to time in the past thirty years. The electro-pneumatic interlocking switch signal system in the New York station and on the electric line between Sunnyside Yard, L. I., and Manhattan Transfer, N. J., alone cost $1,750,000. It takes a normal force of 1,800 men to maintain the Pennsylvania's signal system. It costs to maintain these signals $1,500,000 a year.

RAILWAY CONSTRUCTION

The Alabama, Tennessee & Northern is contemplating extending its line 25 miles from Reform, Ala., to connect with the Frisco and the Illinois Central.

The Alberta & Great Waterways has completed 35 per cent of its grade to Lac BaBiche, and the balance will be completed by September 15.

The Vank Construction Company has been awarded the grading contract for overhead crossing for Baltimore & Ohio at Concord Ave., Wilmington, Del.

Construction may be started at once on Beaver, Meade & Englewood to connect with Wichita Falls & Northwestern at Forgan. J. W. Webb, Beaver, Okla., is interested.

The department of railways of British Columbia has approved the plans of Canadian Pacific for a further extension of its line on Vancouver Island to Duncan Bay.

The Chicago & North Western is contemplating a branch from Kingston, Wis., northwest to Crandon, it is said.

The Chicago & North Western is reported to be planning an extension this fall from main line near Antigo, Wis., to tap timber land north of Menominee Indian reservation.

E. A. Everett.

E. A. Everett has been appointed a sales representative of the Gordon Primary Battery Co., with offices in the Peoples Gas Building, Chicago.

Mr. Everett began railway work in 1891 in the signal department of the Michigan Central R. R. He was promoted through the positions of signal inspector, maintainer, supervisor and signal

E. A. Everett.

engineer, which position he left July 10, 1911. During this period he has had a very considerable experience with signal batteries and his knowledge of primary batteries was made use of by the Railway Signal Association, he being chairman of the sub-committee on primary batteries. He was a member of Committee No. 4.

The Old Track Gang.

[INDIANAPOLIS NEWS]

'Twas just an ould photograph, faded an' yellow,
Long treasured in somebody's album, Oi know,
But from it came mimories, sacred an' mellow,
Thot gave me back fri'nds av a glad long ago.
It brought to me moin th' ould thrack gang begorra,
Thim b'ys as well knew how a rail should be laid;
Thim lads as could work all tonight and tomorrow,
Thin sphit on their hands an' go livel a grade.

Though humble an' poor, they were min, let me tell ye,
Wid gintlemens proide in their sinew an' bone;
Their hearts were as babes if a sorrow befell ye,
But pity they'd not for a blackguard or drone.
Down there on the thrack wid their shovels an gauges,
Their picks an' their crowbars av hefty desoign.
Ye heard not a word about history's pages,
But: "Squint at thot rail, lads, an' git it in loine"

Shure they had no derricks or fancy invintions,
For liftin' the rails from the top av the car;
They used Oirish muscles av Trojan diminsions
An' tumbled thim off wid th' aid av a bar.

They tamped ties an' laughed av their own youthful glory
Whin they wint a sparkin on Erin's ould sod;
They paused now an' thin for the joke av a story
An' pitied poor divils thot carried th' hod.
At noon, whin th' boss sounded truce for an hour
Their dinner pails filled iv'ry innermost nade;
Thin, peaceful an' calm as a midsummer shower,
They shomoked their dudeens in th' cool av th' shade.
But thim was th' ould days, days sacred an' mellow,
Whin thracklayin' shkill was a virtue, begob,
So take off yer hat to ould ganius, young fellow;
Thim b'ys could build railroad – an' loaf on the job!

The Maintenance of Way Department

RAIL CREEPING—NO. 13.

A Trackman.

There are several causes for rail creeping and there are a number of methods to prevent it. The one serious cause, however, is the fact that efficiency in foremen has not kept up to date with the high rate of speed and heavy motive power. In renewal of rails great care should be taken when spiking to hold the rails where laid. In spacing ties on single track always work against the heavy traffic; on double track work east on west-bound track and west on east track and tamp and fill each joint as soon as spaced.

In raising track never raise it so high that there is not sufficient material to properly fill the track again. For open track will creep fast and when once started is hard to hold. Anti-creepers are of great value to any good trackman, but are money thrown away when sent to incompetent foremen. It requires attention on the foreman's part, when picking scrap, to replace the creeper, not scrap it or leave it in the ballast where it dropped off. Put it to use again.

THE TRACKMAN, Big Flats.

"RAIL CREEPING"—NO. 14.

A Burgett, Supervisor.

"Rail creeping"—only two words, yet they mean a great deal to the supervisor and section foreman, who are bothered with keeping rail on their territory and have the task of keeping their track in good, safe condition for fast speed and heavy traffic. On the Erie we are bothered most with creeping rail across the fills, on marsh or muck land, and on down grade track which left our track very kinky, joints low and joint ties badly skewed, and also left a very jerky riding piece of track. Also track would kick out of line very badly on hot days, which would necessitate cutting the rail to allow getting the track in proper alignment. It was necessary to have a track walker over this track constantly and special orders put out for all trains to reduce speed. Also caution signals and slow boards were put up and lamp signals displayed at night on slow boards, this in addition to special orders to trains, so there would be no failure of trains to observe the orders over this treacherous kind of track.

Where we had the worst rail creeping track was on a six-foot level sand sub-grade, with marsh or muck land underneath. This was on new double track, of 90-lb., 33-ft., ARA "type B" rail, with continuous rail joints with enclosed spike holes, twenty ties to the rail, 7"x9"x8½', with six inches of gravel and sand ballast under ties. To remedy this condition it was necessary to straighten and respike the joint ties, and space at least two ties on each side of the joint, and in a great many cases take the shoulder tie from one side of the joint and place it on the other side, as the rail had run badly and bunched the ties. The expansion in the rail was very irregular, and most of the rail had to be run back, so expansion would be right for the change in temperature. Then we gave the track a twelve-inch lift on stone ballast. After this had been done we applied anti-rail creepers, eight to each rail length of track, and the track has practically stopped creeping. Where formerly our trains were making 30 miles per hour they are now making 60.

We handle daily nearly 1,500 freight cars on each track, in addition to six passenger and express trains. I would suggest that, especially on double track, a good anti-rail creeper be applied on all main tracks as soon as laid, and thereby stop rail creeping. Otherwise the track will not only cause a lot of trouble but result in a very heavy expense to the company to adjust the track, and then to stop or reduce this rail-creeping to a minimum it will be necessary to use a good anti-rail creeper anyhow.

I had a two-mile piece of track laid without spiking the joint ties; this was 90 lb., 33-ft., ARA "type B" rail, twenty ties to the rail. As this was on double track, on a two-tenths per cent down grade, traffic was only one way and the rail crept about twelve inches in six months, but did not leave track in a kinky condition; joints kept fairly good surface and ties practically straight, but spoiled the spacing of joint and shoulder ties. While the non-spiking of joint ties helps out, perhaps, in the surface and alignment of the track, where no rail creepers are used, yet we are confronted with the necessity of spacing the joint and shoulder ties again; and from my experience and observation I would say spike joint ties and put on the anti-rail creepers before track has run and save the company money and a great deal of worry and hard work for the supervisor and section foreman.

RAIL CREEPING—No. 15.

Supervisor.

My district is all double track, 90-pound rail, 33-foot lengths. Ties under rail are 7x8x8½, white oak, 20 ties per rail length. There is 27 miles of gravel ballast and 45 miles of stone and chatts ballast. The depth of ballast under the track is 14 to 16 inches. Traffic is all one way and very heavy and high speed. Our grades are about 1 per cent. Curves are 1 degree. A few years ago we had much trouble with track creeping, the worst places being on descending grades. In fact, several times the track buckled and jumped out. Track not well ballasted will creep much worse than track well ballasted. This is on account of the fact that there is not so much wave motion to the rail while trains are passing over on well ballasted track. Three years ago we began using rail anchors. But we only put them in the worst places, in one-mile and half-mile stretches, and only put one anchor on each joint tie, opposite the joint, as we have broken and suspended joints. The anchors did but very little good, because not enough anchors were put on to hold the rail. We now have 37 miles of track with 12 rail anchors on each panel of track. This track is stone ballast, and there is no creeping of rails in this stretch of track. We use the "P. and M.," the "Vaughn" and the "Positive" rail anchors. Unless there are enough anchors put on, I think it is only a waste of time and money to apply them. The number of anchors to put on a panel of track depends upon weight of rail and how well your track is ballasted and speed and weight of trains.

RAIL CREEPING—NO. 16.

By a Trackman of the North.

I will first deal with rail creeping under the conditions of light sub-grade or fill. By this I mean swamp or muskeg land, with grade of same material, which is always soft when wet and usually very light when thoroughly dry. There are other kinds of material which do not give satisfactory results when wet but do when dry; therefore it goes without saying that too much care cannot be given to drainage of right of way.

I may say that I have seen cases where thorough drainage has practically removed all rail creeping where before great trouble had been experienced, but in addition to this there must be uniformity of track; that is, ties must not be less than 9" face and if hewn must be uniform and in perfect line, so that both sides of rail will have full bearing without adzing ties, and should be of such a length as to give within 6" of as much of the tie outside the rail as there is from rail to center of track, thus giving the tie as nearly as possible equal surface bearing on both sides of rail (when properly tamped). Tamping has, in my opinion, more to do with rail creeping or the prevention of it than is commonly recognized. Ties should be spaced, not from center to center (as is common on many roads in Canada and, from what I read, I suppose also in the United

States), but from the outsides. This would give a uniform space between sides of ties, which should be not more than 9", thus doing away with long and short spaces where rail has no support. Uniform spacing has a great deal to do with preventing rail from creeping.

We will now give attention to the rail. I have found that where the weight of rail was increased in proportion to the rolling stock the tendency to creep largely disappears. I have only encountered one piece of track on tangent that I could not control in this manner. This piece was on light fill with light coating of sand ballast on heavy down-grade to diamond crossing with ties averaging 2' 6" centers under 60 lb. steel, and carrying in addition to light local traffic one train of twenty 80,000-lb. capacity cars of coal every second day. Loads always going down grade toward the crossing made heavy application of brakes necessary, and caused great trouble from the difficulty under discussion, forcing the diamond out of line until trains on the line crossing ours could not, in some cases, proceed until the track had been lined back. When I took charge of this piece of track the section forces had arranged a number of short sections of rail in the track ranging from 3' to 15' in length, and in place of a round bolt hole in the end of the rail, there had been formed an oblong hole, the same also being done with fish-plates. This enabled them to drive the track back from diamond for the distance of about a mile, taking up all expansion, then the short pieces of rail were placed in track at the diamond with all the expansion that could be had by the above arrangement, and as traffic drew the track towards the diamond and closed up the expansion the short rails were rearranged and some taken out to keep track from buckling. The joint ties that were slot-spiked to angle bars shifted in some instances over 12" in 24 hours. This piece of track required almost constant attention, and although signals were set at proceed, trains had to approach with care, expecting to find the track out of order. Signals had often to be disconnected and the derail spiked on account of track creeping putting the adjustment out of order. On taking charge I immediately set to work to find some remedy for these conditions. I decided to put a pair of angle bars on the center of every second rail, starting the fourth rail from the diamond and working from it for one mile, which reached about the top of grade, drilling one hole in each rail; I had angle bars bolted tight to the rail through one of the center holes. I then placed two ties under the angle bars and spiked them securely, putting spikes in all slots. I then had pieces of wood 4"x4" cut to fit between ties and fitted them in on outside of rail between 14 or 15 ties (including joint ties) in front of or on the side nearest the diamond of ties spiked to center of rail and which were held in position by angle bars, as stated above. This process was continued as far as angle bars had been placed on rail. In this way I had my track anchored to over one-half of the ties for more than a mile. I had blocking secured to ties to prevent it from shifting and covered it with ballast. Old cedar fence rails were cut up for blocking. This effectively stopped all rail creeping on this piece of track, and I was able to remove all short pieces.

My experience with curves and track creeping on same is somewhat limited, but will give my experience with a piece of track. In this case the creeping took place in opposite directions, the outside rail traveling in one direction, while the inside rail moved in the opposite one. The particular case that I will endeavor to deal with is single track, a continuation of curves covering a distance of about seven miles, descending from both directions to the center into a valley on grades ranging from ½ per cent to 2 per cent and through cuts taken out of gray shale and over short, deep fills made of the same material. This track handled the local traffic of 300 miles through a good farming district with 100 per cent motive power on a 56-lb. rail secured with angle bars. I took charge of this piece of track a little over two years ago and found rail creeping to be general, but it did not in every case incline to go down grade, as I had supposed it should. After close observation I decided that three things were largely responsible for the rail creeping, the first being the very uneven condition of the ties, next the line, and last, but not least, the elevation of the track. There being a slow board at top of grade at both ends of this piece of track, there was little difference in the speed of any train over another, whether passenger or freight. After arriving at a conclusion purely from observation, I applied what I considered first aid, that is, after rearranging the expansion in track, I respaced all the ties on a reverse curve that were badly out of condition, surfacing the track at the same time for about 1,000 feet, leaving on the track about one-half of the authorized elevation and putting it in good surface and line. After three months' trial of this, when there was considerable wheat passing over the line, the results were such that I have gone over most of the curves on this piece of track in the same way and our creeping trouble has almost disappeared, although I have no anti-rail creepers on it.

I am of the opinion that where speed will allow of it, that is, on a track where the speed of all trains is nearly equal, great assistance can be given to track by bringing the elevation down to the minimum. This also increases the hauling power of the engine, while the train pulls much easier, thus relieving track of unnecessary strain, as the position of the cars makes the peculiar action of the wheels necessary under such conditions much easier than it would be with full elevation.

While in both the cases I have described there were no anti-creepers used, still I figure that in the first case my arrangement was about equal to the application of anti-creepers on the rail at every second tie; in the second instance there being very little tangent and the curves being short and reversing about equal, the one rail seemed to tend to regulate the other when track elevation is regulated to suit. This may be putting me counter to the ideas of engineers, although I have no wish to be so, still the results are as I have stated.

A MAINTENANCE OF WAY SERMON.

By Steve.

Text: "And he labored with all his heart...and he prospered."

In reading articles written by trackmen to *Railway Engineering*, and in conversing with trackmen in general, I find that the tendency is to blame those occupying positions superior to their own for their own shortcomings, so I am taking this text: "And he labored with all his heart...and he prospered." My theme is "Faultfinding" (the bane of trackmen). I am submitting this as I would were I addressing an assembly of trackmen.

You, Mr. Laborer, blame the foreman for your own delinquencies. You, Mr. Foreman, seek to cast reflections upon the integrity of the roadmaster and higher officials; you are casting slurs upon the character of men who undoubtedly have been selected to fill those positions through their sterling worth and ability. Stop! Reason with yourself. Do you realize that while you are assailing the character of these men you are debasing your own? You are forgetting to cast the beam from your own eye before looking for it in the eyes of others—those whom you are trying to debase.

Your superintendent, division engineer and roadmaster did not earn their positions by looking for defects in the methods which others in higher capacities than their own were using successfully. They spent the time you are wasting in looking for the defects within their own selves and striving to remedy them.

When you buy anything you expect to get full value for your money, don't you? You are selling your labor, and your employer expects to receive full value for his outlay. Are you giving it? Or are you repaying him by finding fault with him because he does not countenance indolence or poor work upon your part? Stop and consider and you will invariably find that the fault is within yourself.

You, Mr. Laborer, find fault with your foreman because you are not recommended for or given the position of assistant foreman or foreman when a vacancy occurs. Have you shown your foreman by your daily toil that you are worthy of the position to which you aspire? Surely you have not, for if you had he would have called the roadmaster's attention to you. If you had labored with all your heart the roadmaster would have noticed it himself and would have asked the foreman about you. It lies fully within yourself whether you win or lose. Do you realize that life is a battle from start to finish, and to win you must be up and doing? During your school days you were in competition with all your classmates; you did not expect your instructor to credit you with perfect lessons when you did not have them perfect. You fully realize, even in childhood, that your advancement depended upon your industry and constant application to your studies. The percentage of perfection you attained in those studies denoted your understanding of the subjects, did it not? Then why, after you have attained manhood, do you expect promotion when your own intuitions compel you to admit to yourself that you have not labored with all your heart? Finding fault will not do your work, nor will it increase your ability. Discrediting others will not improve your condition; by doing so you are simply declaring your incompetence. It is not the man who is finding fault that progresses. It is the man that is doing things—while you are nursing fancied grievances—that forges ahead. You waste precious moments in faultfinding that should be used in studying yourself. This applies to all trackmen, roadmasters, foremen and laborers alike. The uplifting of our craft demands of us that we study ourselves. You say, "I am doing enough for the pay I am receiving," but when there is a vacancy in a position higher than the one you now occupy, one which you aspire to fill, you wonder why you are not selected to fill it. You are dissatisfied with the management because it does not recognize your ability to fill the position. You were in competition with the man who "landed the job." Be honest with yourself and acknowledge that it was the other fellow's percentage of ability that won over yours.

You sit and brood over your defeat. You try to shift the responsibility of it upon others. You say "you would have landed that job if you had a pull." That is very true; but not in the sense which you infer. The pull must not come from others, but from within yourself. You liken yourself to a balky horse; you have noticed how the horse will foolishly look around, bite his bit, refuse to be led or driven; he is a fit representation of yourself, with but a fraction of your sense. The fellow who "landed the job" pulled cheerfully, and his ability—concede it—landed it. Sink this deep into your mind: Ability is the strongest pull on earth. Faultfinding is nothing more than pulling back; you have no idea until you have cast this self-inflicted curse from you what a fool you have been. No man ever pulled back in any walk of life who did not cast a reflection upon his own character. This life has its daily battle; ask yourself each evening this question: Have you won or lost in the battles of the day just past? Face each problem squarely; each man alongside of whom you work is a competitor, be not so foolish as to belittle him; face him or his proposition squarely, win honestly or not at all. That is undoubtedly the way you wish him to win over you. Be sure to study and prepare, keeping in mind that you must consider what the other aspirants are doing and strive to make a better showing than they do. You cannot win with hands down; your advancement depends entirely upon your own ability to solve the problems which you go up against daily. You are not fully prepared to fill the position to which you aspire until you have, to the best of your ability, reviewed and adopted the different methods which others in the same class of work are using successfully. You must be master of yourself before you can consider yourself fit to dictate to or supervise the work of others. You make errors, all persons make them; be true to yourself and acknowledge them. By doing so they will become "stepping stones" to your success. Do not try to shift the responsibility of them from your shoulders onto the shoulders of others; carry your own burden and you will be a better man for it.

Your biggest task each day is loosening the "millstone" from around your neck—that of casting your little faults from you. You may have been a little indiscreet the night before, lost some money in a "quiet little game," or may have "imbibed" a little, resulting in a headache or a grouch.

When accosted by your fellow workers with a cheery "Good morning" you have not the good manners to respond; you shrug your shoulders, seeking to cast a slur upon their characters, mistrusting your fellow workmen. Do you realize that in nursing these assumed grievances your independence and judgment are being placed in jeopardy and that you are being tried by the highest tribunal in the land, the Court of Public Opinion? Cast them from you, shun them as you would a pestilence; they suck at your life blood. Do not allow your faults to deceive you; be master of yourself, be ever self-reliant, self-controlled. Guard against the curse of faultfinding, for a curse it surely is. It lies entirely within yourself, and before you can hope to succeed you must cast it from you, for it is the beam in your own eye; you cannot see what is good and pure in others while you let it remain there. You cannot succeed by being a detractor, for the moment you try to besmirch the character of another, your fellow workers begin to lose confidence in you and your progress has taken a step backward.

You, Mr. Laborer, think you are a much abused creature because you are still on the bottom rungs of the railroad ladder. You think the "boss" is to blame because you are not climbing up.

The first day you entered the employ of the company the "boss" put your foot on the bottom rung. It was then up to you to climb. What effort are you making? No one can answer this question better than yourself.

Efficiency is the only standard by which you are weighed. The other fellow won while you lost. The only reason why he did so was, the beam on the scale of efficiency showed more weight in his favor than it did in yours. Perhaps you do not understand the meaning of the word "efficiency." It is doing whatever is to be done, doing it on time, doing it so well that no one can do it better. Your only hope, Mr. Trackman, if you wish to succeed, is through efficiency; you cannot rank as an efficient worker, foreman or official unless when you are given a task your superior in rank can dismiss it from his thoughts, assured in his mind that it will be well done and on time; and to give him this impression you cannot slight the "nooks and corners" of the task assigned you.

I am fully convinced that you all wish to succeed; no one desires to be considered a failure. No matter what station in life you occupy, you hope for success; and it is through the patient plodding and daily mapping out of your plans that you insure yourselves against failure. You will find it very true that "work well planned is half completed."

No matter what position you hold in the employ of a railroad, you are considered either an asset or a liability. Commune with yourself and determine whether you are a liability or an asset; if you are an asset, the railroads will be glad to employ you at any time; other positions will open for you if you do not like the one you now hold. Your assets are your real worth to the company which employs you. Do not be deceived, the railroads either want you or they do not; you are judged solely by what you are as an asset or a liability. The railroad, when it employed you, considered you as so much borrowed capital; the payment you receive each month is the interest on the capital you have invested with the company—a capital of brain or brawn, or both. If you receive an income of $500 per year, your investment is mostly in brawn; if you receive $1,000 per year, your investment is in brain and brawn; if you receive $1,500 per annum, your investment is mostly in brain. Face this squarely, knowledge is supreme, and you must fully convince

yourself that you are judged solely by what you have invested in the company.

Taking 6 per cent as a fair rate of interest, at $500 a year you represent capital to the extent of $8,333.33⅓; at $1,000 per year you represent an investment of $16,666.66⅔; at $1,500 you represent $25,000. If you are not earning the interest on this investment you are a liability and when the person under whose direction you are working considers you as such, your investment is returned to you with the interest paid up to date.

To be an asset, you must be self-reliant; self-reliance will not come to you while you are standing and waiting; it is just ahead of you and you must quicken your pace to catch up with it.

Self-reliance is not conceit nor overconfidence, it is believing that you can "deliver the goods" and proving that you can and are doing it. The self-reliant man stands squarely upon his own feet and asks no man to pull for him; he meets all obstacles face to face; he puts up a vigorous fight and he stays in it until it is won or lost; and if he is defeated he will say as did our California governor, Hiram Johnson, after the last presidential campaign was over, "It was a bully fight, if we did lose." Here is the secret of success: Fight to a finish, win or lose; make your opponent show that he is a better man and that you have to be beaten fairly before he can claim the honors. Let him be convinced that you gave him the fight of his life. Show your courage by still keeping on fighting. You have learned much which will never be forgotten in the fight that you have been defeated in; it has taught you to find your weak spots and shown you where you failed through an overvaluation of yourself. Keep your own counsel; detraction or faultfinding is nothing but cowardice; you cannot afford to be considered a coward. When you feel yourself slipping, "throw sand on your rail" to give yourself a grip to regain your self-confidence and you are sure to get there. You may think that to let up on some of your obligations at times is not going to make much difference, but you can rest assured, for every obligation that is slighted or ignored there appears another which must be paid for at its own price. So, Mr. Trackman, no matter what position you hold, be it roadmaster, foreman or laborer, it is by observation and study only that you can keep abreast with the times. Never allow yourself to forget that the railroad world is progressing daily, and to succeed you must keep in step with this progression.

Do the work that is outlined for you. No one knows how quite so well as yourself. Labor with all your heart and you will prosper.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION.

By W. C. Kidd.

The roadmasters of America will convene at the Auditorium Hotel, Chicago, Ill., on September 8, 1914, in the thirty-second annual convention of the Roadmasters' and Maintenance of Way Association.

Neither disaster nor depression in business has prevented them from assembling from year to year, although it is true that at some of their meetings only a few were present, which required only a small room for discussing various subjects and solving the problems uppermost in their minds.

Prior to 1907 it was predicted that the "good ship" would surely go on the "reefs." In 1908, at Chicago, A. E. Hansen, formerly roadmaster on the Chicago & North-Western, was elected president. When the association met in Washington, D. C., at the old Ebbets House, the following year, it was seen at once by all present, and especially by the young and vigorous members who had been added to the rolls, that a new "lease on life" had been taken "aboard."

As every one knows, James Sweeney, of the Chicago & Eastern Illinois, wielded the gavel at the convention which was held at the Great Northern Hotel in 1910. As a presiding officer he was a success; his opening remarks were received with considerable enthusiasm; the committee reports were voluminous and interesting; and it can truly be said that ever since Mr. Sweeney surrendered the gavel to Thomas Thompson, a roadmaster on the Chicago division of the Santa Fe system, he has worked zealously for the upbuilding of the organization.

At the old Southern Hotel in St. Louis, in 1911, Mr. Thompson had the distinct honor of opening one of the most enthusiastic meetings that ever fell to the lot of a president of that organization. L. C. Ryan, who was at that time vice-president, was justly entitled to succeed Mr. Thompson, but conditions and circumstances over which this young "Trojan" had no control willed otherwise on the morning set apart for the election of officers. One could see clusters of roadmasters in the rotunda of that old hostelry; and the guests present could see that something of importance was about to happen. They had not long to wait, for when Mr. Thompson, with smiling countenance, mounted the platform and with one bang of his gavel called that memorable meeting to order and asked for nominations for president, if I am not mistaken, it was that towering figure from Danville, Ill., who nominated A. M. Clough of the New York Central Lines for president. T. F. Donahoe of the Baltimore & Ohio was made vice-president, and Leo C. Ryan of Sterling, Ill., secretary and treasurer.

There were four hundred and sixty-seven roadmasters in attendance at the convention held in the Statler Hotel in Buffalo, N. Y., in 1912. The members of the Track Supply Association, which was organized in St. Louis the previous year, had a membership of forty supply firms. The upper gallery of the banquet hall and every room on that floor was occupied by exhibits. It was acknowledged the most successful roadmasters' convention held up to that time, both in point of numbers of roadmasters present, the important subjects discussed by them, and the wide assortment of exhibits displayed.

It was at this convention that the Track Supply Association gave its first banquet, which was addressed by such distinguished railroad men as C. H. Stein, superintendent of the Central Railroad of New Jersey; J. V. Neubert, engineer of track of the New York Central Lines, and H. J. Pfeifer, engineer maintenance of way of the Terminals Railroad of St. Louis, Mo.

To have a larger gathering than that which met at Buffalo seemed almost an impossibility. But the strong personality and persistent and untiring efforts of William Shea, roadmaster of the Chicago, Milwaukee & St. Paul Railway at Ottumwa Junction, Ia., who succeeded Mr. Clough as president, with the general committee meetings which he held from time to time, it fell to his honor to call together the largest and most successful convention that had been held under the auspices of the Roadmasters' and Maintenance of Way Association of America.

At this convention, which was held at the Auditorium Hotel, Chicago, six hundred roadmasters were registered. Seven hours each day were given for the discussion of the topics as they were presented from time to time. On the ninth floor of the hotel there were fifty-one exhibitors. At this time the Track Supply Association gave its second annual banquet in honor of the Roadmasters' and Maintenance of Way Association. Every roadmaster present on this occasion had the distinct privilege of listening to addresses by W. L. Park, vice-president of the Illinois Central; H. R. Safford, chief engineer of the Grand Trunk Railway System; James Burke, superintendent of the Erie Railroad terminals at Chicago, together with the characteristic address made by Mr. Shea, the then president of the association, and lastly, but not least, the remarks of Mr. Clough.

At this memorable convention the following officers were elected: T. F. Donahoe, general supervisor of the Baltimore & Ohio, president; C. H. Gruver, roadmaster of the Chicago, Rock Island & Pacific, first vice-president; B. C. Dougherty, roadmaster of the Chicago, Milwaukee & St. Paul, second vice-president; L. C. Ryan, roadmaster of the Chicago & Northwestern was re-elected secretary and treasurer. The executive committee was composed of: Thomas Thompson, of the Santa Fe System; James Sweeney, of the Chicago & Eastern Illinois; P. J. McAn-

drews, of the Chicago & Northwestern; M. Burke, of the Chicago, Milwaukee & St. Paul.

Anyone who is a mind reader could easily see that the 1914 convention is destined to be a crowning glory of that organization, and yet we hear it said that the Roadmasters and Maintenance of Way Association shall lose its individuality.

The speakers who will attend the third annual banquet of the Track Supply Association, which will be given on September 10, will be: A. W. Thompson, vice-president of the Baltimore & Ohio; E. F. Wendt, formerly with the Pittsburgh & Lake Erie and who is now connected with the Interstate Commerce Commission, and Mr. A. T. Hardin, vice-president, New York Central R. R.; and I venture to assert that no organization ever had the pleasure of listening to such distinguished and learned railroad men.

There is not a gentleman who will attend this convention who will not gladly take off his hat to every member of the American Railway Engineering Association, which meets regularly every March at the Congress hotel, Chicago. While a railroad man can purchase locomotives and cars and have them delivered on its tracks, it seldom buys forty or fifty miles of roadbed. That has to be built. It requires engineers to do this kind of business, and it is up to the roadmasters to perform that little (?) work. The management looks to the roadmaster to maintain the roadbed after it is built. Roadbed cannot be bought by the yard.

I earnestly hope that the writers who are making an effort to have half a dozen associations meet at one time will reconsider their actions and not deprive such devotion—such patriotism as we have seen exhibited since a railway was a railway, by the engineers and roadmasters of America.

I say all hail to their power, and may the time come when those who are in charge of the railways will recognize the ability of these men and the fidelity which they have given to the position they hold.

I earnestly hope that every roadmaster in America and Canada who may read these lines will not fail to be present at work and join with the hosts that will be congregated on the ninth floor of the Auditorium hotel, Chicago, during the week of September 8 to 11, 1914. We expect over one thousand roadmasters to be registered on the morning of September 8.

The following supply firms will be present and exhibit only those devices that are used in maintenance of way work:

Carnegie Steel Co., Pittsburgh, Pa.
Southern Railway Supply Co., 113 N. Second St., St. Louis, Mo.
Pittsburgh Steel Co., Pittsburgh, Pa.
American Hoist & Derrick Co., St. Paul, Minn.
Q. & C. Co., 90 West St., New York City.
M. W. Supply Co., Philadelphia, Pa.
American Guard Rail Fastener Co., Real Estate Trust Bldg., Philadelphia, Pa.

Railway Engineering and Maintenance of Way, Chicago.
Railroad Supply Co., Bedford Bldg., Chicago.
Ajax Rail Anchor Co., McCormick Bldg., Chicago.
Templeton, Kenly & Co., Ltd., 1020 S. Central Ave., Chicago.
The National Malleable Castings Co., Cleveland O.
Hubbard & Co., German National Bank Bldg., Pittsburgh, Pa.
Commercial Acetylene Railway Light & Signal Co., 80 Broadway, New York City.
"Frictionless Rail," 683 Atlantic Ave., Boston.
Reading Specialties Co., Reading, Pa.
The Keystone Grinder & Manufacturing Co., Pittsburg, Penn.
The P. & M. Co., Railway Exchange Bldg., Chicago.
The Rail Joint Co., 185 Madison Ave., New York City.
Pennsylvania Steel Co., Morris Bldg., Philadelphia, Pa.
The Track Supply Association, Hillburn, N. Y.
Ramapo Iron Works, Hillburn, N. Y.
Lackawanna Steel Co., 65 Johnson St., Newark, N. J.
American Steel & Wire Co., Chicago.
H. C. Holloway, Railway Exchange Buldg., Chicago.
Railway List Co., Manhattan Bldg., Chicago.
Kelly-Derby Co., Inc., Peoples Gas Bldg., Chicago.
The Prince-Groff Co., 50 Church St., New York City.
Northwestern Motor Co., Eau Claire, Wis.
Hayes Track Appliance Co., Richmond, Ind.
Indianapolis Switch & Frog Co., Springfield, O.
Mudge & Co., Railway Exchange Bldg., Chicago.
Positive Rail Anchor Co., Louisville, Ky.
Wm. Wharton, Jr., & Co., Inc., Philadelphia, Pa.
Sellers Mfg. Co., McCormick Bldg., Chicago.
Crerar, Adams & Co., 239 E Erie St., Chicago.
Verona Tool Works, Oliver Bldg., Pittsburgh, Pa.
Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago.
James C. Barr, 84 State St., Boston.
Fairmont Machine Co., Fairmont, Minn.
The Creepcheck Co., 81 Fulton St., New York City.
Morden Frog & Crossing Works, Commercial Bank Bldg., Chicago.
Spencer Otis Co., Railway Exchange Bldg., Chicago.
The Duff Manufacturing Co., Pittsburgh, Pa.
Union Switch & Signal Co., Swissvale, Pa.
National Steel Tie Co., Harrisburg, Pa.
Simmons-Boardman Pub. Co., Woolworth Bldg., New York.
American Valve & Meter Co., Cincinnati, O.
The Buda Co., Harvey, Ill.
The Pocketlist of Railroad Officials, 75 Church St., New York.
Ajax Forge Co., Chicago.
Elliott Frog & Switch Co., East St. Louis, Ill.

100 TON TUNNEL CRANE.

A double end electric wrecking crane, with independent 100 ton capacity cranes at each end, has been built for the Electric Division of the N. Y. C. & H. R. R. R., the whole being especially designed 1or the underground clearances and conditions existing in Grand Central Terminal. While primarily designed to meet Grand Central Terminal conditions, it is also adapted for use on the main line of the Electric Division, where operating conditions and clearances are such as usually obtain on steam roads. This machine will be dispatched at high speed under its own power to the scene of an accident anywhere on the Electric Division. In fact, it combines the functions of a crane with many of those of a high power electric locomotive. It is completely equipped for high speed, independent operation, with air brakes, whistle, and all necessary fittings.

To design a crane of the large capacity required, under the unusual limitations imposed by the conditions of tunnel operation, was not a simple matter. In the restricted space of the express-level deck of the Terminal, the capacities must be attained under conditions where head room for raising the boom and room at the side for slewing were both restricted, and in addition where excessive concentration of wheel loads must be avoided. In spite of these complications a crane has been built and furnished to the railroad company, fulfilling all the requirements desired. Just as operating conditions in Grand Central Terminal are different from those found elsewhere, so is this crane which was designed to meet those conditions unusual in its features. Nowhere else can be found a crane so well fitted in power or ease of operation for this class of work. The procedure in case of a wreck underground would be somewhat as follows: If possible the wreckage would be lifted clear of the track and the crane would then back out with it. However, if the crane could not raise the damaged equipment off the track—either on account of lack of head room or because of the size of the piece—one end would be lifted with the main hoist and with the auxiliary hoist, a special truck would be placed in under. The crane would then drag away the load.

In construction the crane is unusually massive and of great strength. The car body is 67 feet long, with a wheelbase of 51 feet, and is carried on two compound trucks, made up of two four-wheel trucks each. A cradle on which the car body rests allows the compound trucks, as well as each single truck, to have perfect freedom to swing when taking curves. Complete air brakes are provided, also a hand brake wheel at each end. There is a compre-

hensive system of air-operated telescopic outriggers or jack beams, used to add stability during heavy lifting and to distribute the load over a greater area. These are controlled by valves with suitable levers, and are instantaneous in action, thus combining ease and speed of operation.

At each end of the car is a complete independent crane, with a structural mast and boom, accurately turned roller path and rollers, and the slewing mechanism. All of the motions of operation may be performed independently, and with loads up to the capacities of the motors may be performed simultaneously. A special feature is the air operation of all clutches to insure quick and sure engagement and release. Such a system with suitable levers is at both ends of the car, each operating its respective end, except for the propelling, which may be controlled from either end.

The electrical equipment is noteworthy, not only on account of the power it develops, but because of its flexibility. Six principal motors with a total of 1100 H. P. are used for operating the crane, as follows: Four of 200 H. P. each for propelling, and two of 150 H. P. each for hoisting and for operating the machinery. The propelling motors are direct connected to the axles of the compound trucks, two at each end of the car. They are arranged so that all four may be used for traveling, or if desired only the two at either end. They are capable of operating safely on fluctuations of line voltage between 300 and 750 volts, D. C. Control is from each end of the car, the controllers being arranged for connecting the motors in series, series parallel and parallel. There is also an electrically driven air compressor.

For intermittent and emergency service, as might be required with the third rail out of commission, or when suitable cable connections could not be made with a feed line, there is installed on the crane a high capacity U-S-L Storage Battery. This is ready for instant service to operate the crane independently of any outside source of power. It consists of 230 cells of the pasted plate type connected in series, 25 plates per cell, and has a capacity of 75 amperes for 8 hours, with a maximum discharge rate of 350 amperes for 2 hours. The cells are assembled in 115 two-compartment lead-lined tanks of the standard U-S-L Car Lighting Battery type, and are connected with extra heavy cable because of the high amperage the battery will at times be forced to deliver. The use of pasted plates secures high capacity with minimum weight, and the special construction of the plates insures long battery life under the severe conditions of this particular service. There is a complete testing and charging outfit, in order that the battery may be charged anywhere that connection can be made with a feed line. At each end of the car is installed a switchboard suitably equipped with lamps and instruments, including an ampere-hour meter for use with the storage battery.

The operation of hoisting is by means of a train of cut spur gearing. There is a brake of sufficient capacity to hold the maximum load in any position, or to lower it at a low rate of speed. A combination clutch and brake is provided for dispatch lowering of the block. In addition there is a ratchet and pawl of ample strength to hold the maximum load when the clutch is disengaged and the winch heads are in operation. These winch heads are on either side of the crane, are of 25 tons capacity and are independent in operation on all other mechanisms. The auxiliary hoist is arranged to operate at the same radius as the main block, or at different points on the boom. The boom hoist or radius varying mechanism may be operated with the maximum load suspended from the boom.

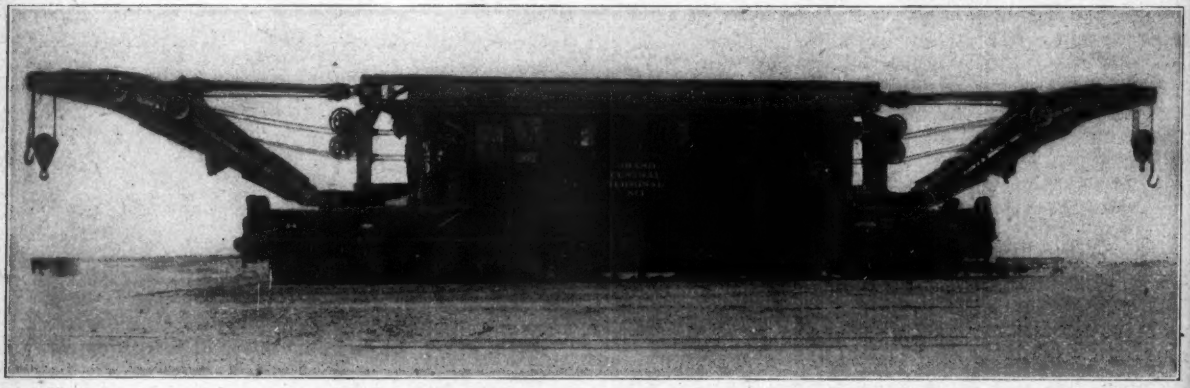
With all four propelling motors in use the crane was guaranteed to travel at the following speeds hauling an 80 ton rolling load:

25 miles per hour on straight level tracks

15 miles per hour on a 27% grade

12 miles per hour on straight level tracks, with the addition of a 50 ton suspended load.

As a matter of fact actual speeds greatly in excess of these were attained. At the formal test conducted by the railroad officials,



Double End, Electrically Propelled and Operated Wrecking Crane.

the crane propelled itself at a rate of 34 miles an hour while hauling an 80 ton rolling load. Satisfactory operation is also possible, using only the two motors at either end of the car, with resulting speeds of about 60% of those when all four motors are used.

In general the following capacities are provided for:

ON SOLID FOUNDATION WITH OUTRIGGERS.

100 tons at 24'-2" radius straight ahead or 6'-6" either side of center.

100 tons at 22'-0" radius straight ahead or 12'-0" either side of center.

100 tons at 13'-8" swinging 180 degrees.

WITHOUT OUTRIGGERS.

50 tons at 24'-2" radius, straight ahead.

25 tons at 13'-8" swinging 180 degrees.

This crane was designed and built by the Industrial Works, Bay City, Mich., from specifications prepared by a committee consisting of H. A. Currie, assistant electrical engineer; B. S. Buell, wrecking master, and C. H. Quereau, superintendent electrical equipment of the New York Central & Hudson River R. R.

CONCRETE FENCE POSTS, PENNSYLVANIA RAILROAD.

The Pennsylvania Railroad is one of those railroads making an extensive use of concrete fence posts for right-of-way fencing. These posts are of the D & A type, being a combination of half round and rectangular shape, with one flat side to which the wire is fastened. The fencing is fastened by passing a short piece of wire around the post and twisting it around the fencing much in the same manner as telephone wires are fastened to insulators. These posts are now being used on low and marshy ground, the intention being to have the fences in these localities replaced first, since wooden posts have a tendency to float and are subject to the danger of destruction by fires.

A fence post plant is being operated continuously at Germantown, Ind., the posts being cast in sheet steel molds, stacked in piles to cure and then hauled out in cars to the desired points.

Personals

R. S. MARSHALL has been appointed superintendent of the *Seaboard Air Line*, with office at Richmond, Va. Mr. Marshall was born on March 15, 1880, at Rock Island, Ill., and received high school education at Anaconda, Mont. He entered railway service when 16 years of age with the Great Northern and remained with that road until 1902, being chief clerk to superintendent when leaving. From October, 1902, to September, 1905, he was with the Chicago, Rock Island & Pacific as division accountant and chief clerk to division engineer. He was with the Panama Railroad from September, 1905, to September, 1907, as chief clerk to general manager and local auditor at Colon, Panama; with the New York, New Haven & Hartford R. R. from September, 1907, to November, 1910, as statistician, general superintendent's office, and with the Minneapolis & St. Louis from November, 1910, to July 1, 1914, as assistant to vice-president and superintendent.

THE PROTECTIVE SIGNAL MANUFACTURING COMPANY, Denver, Colo., has appointed William R. Garton & Co., 299 Broadway, New York, its general sales agent for the United States.

A. M. MACGILLIVEAY has been appointed district engineer of the *National Transcontinental of Canada*, vice M. C. MacFarlane. His office is at St. Boniface, Man.

E. W. FOWLER succeeds N. Noailes as roadmaster of the *Cumberland Ry. & Coal Co.* at Glace Bay, N. S.

T. E. BARRINGER succeeds D. E. Foley as supervisor of the *Illinois Central* at Carbondale, Ill.

G. H. JEDELE succeeds J. J. Daley as roadmaster of the *Lake Shore & Michigan Southern* at Alliance, O.

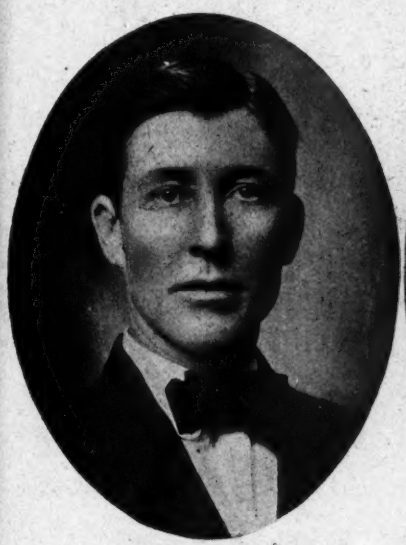
J. J. DALEY, roadmaster of the *Lake Shore & Michigan Southern*, has been transferred from Alliance, O., to Dunkirk, N. Y., succeeding H. B. Shoemaker.

T. J. SEXTON succeeds John Ennis as supervisor of track of the *New York Central & Hudson River* at Rochester, N. Y.

E. A. WARREN succeeds H. Easley as assistant roadmaster of the *St. Louis Southwestern of Texas*, with office at Hamilton, Tex.

W. B. HARRIS succeeds R. M. Nall, Jr., as roadmaster of the *San Antonio & Aransas Pass*, with office at Yoakum, Tex.

A. L. GAUTHIER has been appointed general foreman bridges and buildings of the *Boston & Maine*, succeeding B. D. Dean. His office is at Boston, Mass.



C. M. LANGE, Signal Supervisor
B. & O. R. R., Grafton, W. Va.

J. W. MULHERN, Superintendent
Chi. Gt. Western R. R., St. Paul.

W. A. STEWART, Foreman B. & B.
Cent. Vt. Ry.

J. W. MULHERN has been appointed superintendent of the *Chicago Great Western*, with office at St. Paul. He succeeds W. B. Causey.

R. S. BAXTER succeeds W. H. Roberts as roadmaster of the *Kansas City, Mexico & Orient*, of Texas, with office at San Angelo, Tex.

T. E. WHITE has been appointed supervisor of the *Louisiana & Arkansas*, with office at Minden, La.

F. B. MARBLE, division engineer of the *Michigan Central*, has been transferred from Niles, Mich., to Jackson, Mich.

C. C. HILL has been appointed acting division engineer of the *Michigan Central* at Niles, Mich.

T. GUINEY, supervisor of track of the *Minneapolis & St. Louis*, has been transferred from Hopkins, Minn., to Marshalltown, Ia.

JOHN COOPER has been appointed roadmaster of *Morgan's Louisiana & Texas*, with office at New Elberia, La.

A. S. YOUNG succeeds H. B. Fleshman as chief engineer of the *Montreal & Southern Counties*, with office at Montreal, Que.

J. M. RYAN has been appointed division engineer of the *Nashville, Chattanooga & St. Louis*, vice C. H. Brodbeck. His office is at Nashville, Tenn.

J. D. MANSFIELD has been appointed roadmaster of the *New Orleans, Mobile & Chicago* at Laurel, Miss.

M. M. MARSH succeeds C. Landrean as roadmaster of the *Northern of Costa Rica*, with office at Siquirres, Costa Rica, C. A.

W. A. STEWART succeeds H. E. Holmes as foreman bridges and buildings of the *Central Vermont*, with office at New London.

R. STRUTHERS has been appointed assistant engineer of the *Chicago, St. Paul, Minneapolis & Omaha*, with office at St. Paul, Minn.

H. B. SHOEMAKER has been appointed engineer maintenance of way of the *Chicago, Indiana & Southern*, with office at Gibson, Ind.

W. H. MANSFIELD has been appointed valuation engineer of the *Delaware & Hudson*, with office at Albany, N. Y.

GEO. RIGHTER succeeds M. O'Donnell as supervisor of the *Erie* at Attica, N. Y.

J. C. WILLIAMS has been appointed supervisor of the *Georgia R. R.*, succeeding M. Mason. His office is at Covington, Ga.

E. BEAUSOLEIL succeeds J. Henderson as supervisor of track of the *Grand Trunk* at Ottawa, Ont.

T. YERROW succeeds C. Mitchell as supervisor of track of the *Grand Trunk* at Lindsay, Ont.

FRED FELTON has been appointed assistant roadmaster of the *Great Northern* at Watertown, S. D., succeeding Ole Hermann.

S. SWANSON succeeds R. Hughes as assistant roadmaster of the *Great Northern* at Lakota, N. D.

R. HUGHES, assistant roadmaster of the *Great Northern*, has been transferred from Lakota, N. D., to New Rockford, N. D.

R. M. NALL, JR., roadmaster of the *San Antonio & Aransas Pass*, has been transferred from Yoakum, Tex., to Kenedy, Tex., succeeding W. C. Park.

H. T. ROBERTSON has been appointed roadmaster of the *San Benito & Rio Grande Valley*, with office at San Benito, Tex.

JAMES GALLAGHER has been appointed roadmaster of the *Uintah*, with office at Mack, Colo. He succeeds John Heslin.

J. B. CONLEY succeeds A. M. Kline as supervisor of the *Waynesburg & Washington*, with office at Waynesburg, Pa.

G. F. MCCORMACK succeeds C. M. Kipp as roadmaster of the *Southern Pacific* at Marysville, Cal.

J. D. MCMAMARA has been appointed roadmaster of the *Norfolk & Western* at Portsmouth, Va.

L. M. FLEMING succeeds O. West as roadmaster of the *Atchison, Topeka & Santa Fe* at Dodge City, Kan.

H. E. ASTLEY has been appointed division engineer of the *Central New England*, with office at Hartford, Conn. He succeeds W. D. Warren.

C. M. LANG has been appointed signal supervisor of the *Baltimore & Ohio* at Grafton, W. Va.

W. H. RIFE succeeds C. R. Cowherd as signal supervisor of the *Atchison, Topeka & Santa Fe* at La Junta, Colo.

A. T. DICE, JR., has been appointed assistant supervisor of the *Atlantic Coast Line* at Camden, N. J., succeeding M. S. Miller.

G. A. ARGENBRIGHT succeeds G. O. Everhart as supervisor of the *Baltimore & Ohio* at Massillon, O.

C. O. EVERHART, supervisor of the *Baltimore & Ohio*, has been transferred from Massillon, O., to Youngstown, O.

G. S. HARDEN succeeds J. C. Horning as roadmaster of the *Buffalo, Rochester & Pittsburgh*, with office at Bradford, Pa.

B. D. DEAN succeeds A. A. Page as supervisor bridges and buildings of the *Boston & Maine* at Concord, N. H.

THOMAS TURNBULL has been appointed assistant chief engineer of the *Canadian Northern*, with office at Winnipeg, Man.

B. F. SMITH has been appointed as division signal foreman of the *Atchison, Topeka & Santa Fe* at Arkansas City, Tex.

WILLIAM E. CLARK, for many years in charge of outside track inspection of the Rail Joint Company, New York, died at the home of his son in Charlestown, N. H., on July 5.

THE TERRY STEAM TURBINE COMPANY, Hartford, Conn., has appointed Fidanque Bros. & Sons, 15 Whitehall street, New York, as its representatives for the republic of Panama and the Canal Zone. The Cleveland, Ohio, office of the Terry Steam Turbine Company has moved from 710 New England Building to 503 Union Building.

PORTABLE BUILDINGS OF WOOD.

Portable buildings for the use of construction gangs, bridge and building gangs for either temporary or permanent purposes are sold ready made by the Ford Sales Co., 140 So. Dearborn St., Chicago.

These buildings are made of first quality pine lumber, with walls and floors in sections completely finished and ready to bolt together. The roofs are covered with 80-lb. red slate surfaced roofing, which is guaranteed for fifteen years. The outsides of the structures are painted one coat of grey.

The sections are easy to take down and put up, and are interchangeable. The floor joists are hung in steel stirrups. The buildings are manufactured in large quantities by machinery and the sections may be made to form any kind of a house from the smallest windowless variety to the very largest bunk

Industrial Notes

J. S. HOBSON, recently appointed general sales manager of The Union Switch & Signal Co., at Swissvale, Pa., entered the railroad service as engineer apprentice in the shops of the Great Southern & Western Railway of Ireland in 1884. He came to this country in 1889 and was employed by the C. B. & Q. as locomotive machinist, draughtsman and signal inspector. In January, 1892, he became construction foreman for The Union Switch & Signal Co., in the Chicago district, and in 1895 was appointed supervisor of electric signals for the Michigan Central at Detroit. When the position of signal engineer was created by the Santa Fe, Mr. Hobson was chosen to fill it, in October, 1897, and he remained in that position until he reentered the service of The Union Switch & Signal Co., in January, 1901, as assistant engineer. Later he became assistant general manager and western manager, from which position he has recently been promoted to the general sales managership.

W. H. CADWALLADER, who has just been appointed general manager of The Union Switch & Signal Co., at Swissvale, Pa., was born in Pittsburgh, Pa., in 1876. When he was three years old his parents moved to Wilkinsburgh, Pa., where he has lived ever since. In 1891 he entered the employ of The Union Switch & Signal Co., as blue-printer at the age of 15. In February, 1892,

W. H. CADWALLADER, Gen'l Mgr.
Union Switch & Signal Co.

he was made messenger in the office of the superintendent of works, later on becoming clerk in the same office and in the general manager's office. In 1901 the specification department was created and Mr. Cadwallader was put in charge of it. Later he had charge of the estimating department, and in 1912 he was made assistant general manager, from which position he was promoted to the general managership.

In the United States District Court in Buffalo, on July 21, Judge Hazel appointed James O. Moore and James A. Roberts receivers for the U. S. Light & Heating Co., following a case in equity. That it was a case in equity and not in bankruptcy was made evident in the hearing. It was clearly outlined by the court that there should be no interruption in the fulfillment of existing contracts, in the prosecution of pending business or in the company's operations in any department. A. H. Ackerman, vice-president and general manager prior to the receivership, was immediately appointed general manager to operate the business, because of his familiarity with it, and the entire staff of salesmen, engineers, etc., were retained in their former capacities. Mr. Ackerman has issued the following statement to the trade and to the public: "The action recently sustained in the appointment of the receivers for the property of the company was a necessary step to conserve the assets for the benefit of all. With assets of three dollars for every dollar of debt, the company is amply stable, and the court's direction to continue the business is the last proof necessary to reassure the buying public. There are already under way plans for broad financing, and with the return of general prosperity in the country, the USL, more aggressive than ever before, intends to secure its full share of the business and to continue the manufacture and sale of its special electrical products."